UNITED STATES DEPARTMENT OF AGRICULTURE

REPORT ON THE AGRICULTURAL EXPERIMENT STATIONS, 1934

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UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF EXPERIMENT STATIONS

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REPORT ON THE AGRICULTURAL EXPERIMENT STATIONS, 1934

By J. T. Jardine and W. H. Beal[1]

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INTRODUCTION

The acts appropriating Federal funds for the support of State and Territorial agricultural experiment stations require the Secretary of Agriculture to ascertain whether the funds so provided are expended and accounted for in accordance with the acts; to furnish such advice and assistance as it is thought will best promote the purposes of the acts; to coordinate the work of the Department of Agriculture with that of the stations; and to report thereon to Congress.

This report, prepared in compliance with the above requirements, deals primarily with the use made of $4,430,973 of Federal funds provided by the Hatch, Adams, Purnell, and supplementary acts ($90,000 to each State, $15,000 to Alaska, $58,344 to Hawaii, and $37,629 to Puerto Rico) for the support of agricultural experiment stations in the several States and in Alaska, Hawaii, and Puerto Rico during the fiscal year ended June 30, 1934. It is not, however, confined to an account of the use made of the Federal funds, but gives a general survey of the work of the stations as a whole, whether supported by Federal or State and other funds, and discusses various pertinent questions of organization, administration, personnel, research facilities, needs, trends, and public service of the stations.

[1] With the collaboration of other members of the Office staff.

INCOME

The total income of the stations for the year ended June 30, 1934, was $14,188,455, as compared with $15,576,633 for the previous year, showing a reduction of $1,388,178, or 8.9 percent. Of the total income, $4,361,000 was derived from appropriations under the Hatch, Adams, and Purnell Acts and $69,973 from appropriations to the Department of Agriculture for the benefit of the experiment stations in Hawaii and Puerto Rico.

The income of the stations from all sources for the fiscal years 1933 and 1934 is shown in table 1.

TABLE 1.—*Income of the experiment stations from all sources for the fiscal years 1933 and 1934*

Sources of funds	1933	1934
Hatch Act	$750,000.00	$750,000.00
Adams Act	729,000.00	731,000.00
Purnell Act	2,886,000.00	2,880,000.00
Appropriations for insular stations	103,530.00	69,973.00
State appropriations and allotments	7,740,247.56	6,704,469.23
Fees	414,415.94	460,025.10
Sales receipts	1,151,251.92	1,310,207.49
Miscellaneous income	509,242.70	542,717.65
Balance from previous year	1,293,514.86	740,062.72
Total	15,576,632.98	14,188,455.19
Income 1933 over that of 1934	1,388,177.79	

The income from other than Federal sources during the fiscal years 1933 and 1934 is shown by States in table 2.

TABLE 2.—*Income of the experiment stations from other than Federal sources for the fiscal years 1933 and 1934*

Station	1933	1934	Station	1933	1934
Alabama	$275,310.94	$190,637.35	Nebraska	$181,024.53	$160,391.05
Alaska	1,167.70	5,426.29	Nevada	8,064.51	9,133.04
Arizona	94,530.68	77,107.14	New Hampshire	44,695.09	47,894.03
Arkansas	94,135.87	66,417.51	New Jersey	508,043.95	446,725.15
California	1,110,086.88	881,237.37	New Mexico	48,182.44	53,122.74
Colorado	130,884.60	133,580.60	New York (Cornell)	1,056,233.39	667,513.05
Connecticut (State)	277,315.94	205,191.13	New York (State)	439,281.96	380,114.64
Connecticut (Storrs)	52,048.11	38,258.44	North Carolina	103,861.96	100,133.55
Delaware	30,763.90	35,340.33	North Dakota	194,763.70	87,693.91
Florida	358,654.83	327,546.24	Ohio	651,631.41	689,985.67
Georgia	42,558.48	35,881.47	Oklahoma	174,802.10	162,776.83
Hawaii	29,071.92	21,694.78	Oregon	201,833.20	185,019.49
Idaho	35,664.88	25,173.14	Pennsylvania	134,384.31	153,152.49
Illinois	380,910.03	366,669.40	Rhode Island	7,602.64	5,589.03
Indiana	601,811.62	626,903.35	South Carolina	96,311.45	113,194.61
Iowa	294,419.06	240,191.93	South Dakota	45,065.78	39,028.32
Kansas	175,248.05	172,149.91	Tennessee	29,075.21	32,934.11
Kentucky	221,470.13	243,035.74	Texas	543,601.67	489,957.54
Louisiana	128,971.94	79,204.32	Utah	74,565.79	66,240.41
Maine	68,611.17	50,741.12	Vermont	22,619.13	22,001.80
Maryland	136,363.81	98,041.96	Virginia	86,665.93	85,980.85
Massachusetts	240,301.01	219,902.01	Washington	120,645.11	77,254.49
Michigan	297,163.15	262,818.26	West Virginia	86,980.70	70,322.84
Minnesota	387,322.99	369,692.84	Wisconsin	372,129.86	439,749.00
Mississippi	90,194.85	103,288.53	Wyoming	84,549.57	75,041.29
Missouri	116,159.72	121,786.09			
Montana	126,285.33	98,615.01	Total	11,114,072.98	9,757,482.19

The income of the experiment stations from other than Federal sources, $9,757,482, was 68.7 percent of the total, and $1,356,590 or 12.2 percent less than for the preceding year. The decrease in income was due mainly to a reduction of $1,035,778 in State appropriations and allotments and of $558,852 in the amount of balances carried over from the preceding year. The sales receipts were $158,955 greater than in 1933, while fees and miscellaneous income did not show marked changes. While the decline in total State support for all stations, which began in 1931, continued in 1934, the number of stations recording increases in these items rose from 8 in the preceding year to 15, with increases ranging from $1,068 to $67,619 and totaling $231,600. The reductions in income reported by the remaining 37 stations ranged from $617 to $388,750 and from 0.78 to 54.9 percent. The total reductions for these stations amounted to $1,588.190.

For the support of the stations during the fiscal year 1934, the Federal Government contributed, in the aggregate, about $1 for every $2.20 received from State and other sources. This was the smallest relative contribution from supplementary sources recorded for a number of years past. In 1925, the year before the Purnell Act went into effect, the supplementary income was highest in comparison with the Federal appropriations, the stations receiving $6.35 from State and other supplementary sources for every dollar contributed by the Federal Government.

A detailed statement of station income and expenditures will be found on ages 108–120.

PERMANENT IMPROVEMENTS

Especially noteworthy additions to permanent improvements were not numerous nor as a rule large during the year. Nevertheless, necessary research facilities were fairly well maintained and a number of important improvements and additions to land were made possible through various emergency funds and private donations.

Many of the stations in position to take advantage of the opportunities and cooperation offered by the Public Works Administration, Civil Works Administration, and other emergency and relief agencies, undertook the repair and reconditioning of equipment and the improvement of lands and experimental fields. This cooperation was mutually highly beneficial in that the stations offered opportunity for work and in return were able to make repairs and improvements for the maintenance of their buildings and farms, which otherwise, due to reduced State support and, further, to the fact that the Federal station funds, under the law, could be used for these purposes only to a very limited extent, would have been impossible. In the aggregate the value of these improvements amounted to a considerable sum.

For the year ended June 30, 1934, the stations reported $1,528,986 expended for buildings and equipment, including the purchase of books and journals, scientific apparatus, farm implements and machinery, and livestock. This amount, although greater by $76,659 than the amount so used in the preceding year, was still more than a million dollars below the maximum expenditure of $2,565,317 reported for the fiscal year 1931.

The more important improvements were briefly as follows:

A soil tillage experiment station was established under a grant of $110,975 from the P. W. A., at the Alabama Station, and the work carried on there is conducted cooperatively by the Alabama Station and the Department of Agriculture. The equipment of this new enterprise includes a series of nine plats, separated by concrete walls, for work with soils from different States, of a size permitting the use of ordinary field implements. A building was erected to house the technical and scientific equipment. In addition, with the aid of C. W. A. funds, a machinery shed costing $1,200 was built at the station, and a barn costing about $2,700 at the Black Belt Substation.

At the Arkansas Station general improvements, carried out as State projects under the C. W. A., included drainage, betterment of roads, and terracing and other erosion control on the farms of the station and substations. For these purposes $13,300 was expended at the main station, $5,500 at the Cotton Branch Station, $5,000 at the Rice Branch Station, and about $9,000 at the Fruit and Truck Branch Station. The improvements at the Cotton Branch Station included a barn costing about $3,000.

The California Station expended at Berkeley $6,750 for poultry-breeding pens, $31,100 for a veterinary laboratory and barn, $1,100 for rebuilding refrigeration equipment, and $2,500 for a cottage and implement room. At Davis, $2,500 was expended for a storage house for truck crops and $1,125 for other minor improvements, and at the Citrus Station $4,397 for a greenhouse, and $6,289 for a distilled-water plant. The university received a gift of 2,600 acres of forest land in Eldorado County for use as a school and experimental forest.

In Colorado a farm of 94.3 acres costing $2,000 was purchased with State funds for the Mountain Vegetable Substation at Avon.

With C. W. A. labor, the Florida Station at Gainesville and the North Florida Station at Quincy cleared and drained 120 acres of timber land, thinned 40 acres of timber land for pasture, terraced fields, installed a water system, and constructed a barn.

The State university system of Georgia received a gift of a tract of 609 acres for a research station in animal husbandry and forestry. During the year a horticultural and canning building was erected at a cost of about $1,500 at the Georgia Mountain Branch Station at Blairsville.

The Illinois Station cooperated with the Department of the Interior in establishment of a soil-erosion project covering 140,000 acres in McLean County. The station also gave assistance in locating national forest areas, game preserves, parks, and Civilian Conservation Camps in Illinois.

The Iowa Station purchased 200 shares of land for the development of a research program, carried out, in part, in cooperation with the Department of Agriculture. A tract of 4.5 acres was made available for a garden of native grasses, legumes, and other herbaceous plants of economic importance. The station, in cooperation with the Department, also established an experimental nursery for the development and selection of suitable trees, shrubs, grasses, and other plants for use in controlling soil erosion. The station, cooperating with the Department, undertook the organization of a corn-research institute

to encourage and coordinate corn research as related to problems of corn-culture improvement and uses in Iowa.

The Missouri Station purchased a 450-acre farm primarily for experiments in animal husbandry and dairy husbandry.

With the assistance of C. W. A. funds the Montana Station built a scale shed and improved fences and roads on the Fort Ellis farm at a cost of about $3,100, and carried on land clearing and similar improvements at the Northern Montana Branch Station at Havre at a cost of about $1,000.

Under a cooperative arrangement with C. W. A., the Nevada Station furnished tools and teams for cleaning corrals, hauling manure, renovating fences and grading fields, and leveling about 22 acres for irrigation. Over $3,600 was paid by C. W. A. for labor in this project, involving the general renovation of the physical plant of the station. Further work included electrical wiring of barns and sheds, and graveling and sanding grounds and roads, at an outlay for labor of $350 and $840, respectively. In addition, a hay barn, 30 by 60 feet, was built at a cost of $1,120, and concrete head gates, weirs, and diversion dams were constructed at a cost of about $450.

At the Nebraska North Platte Substation a machine shed valued at $2,000 and destroyed by wind was rebuilt, and with C. W. A. funds a program of road improvement was carried out.

Three C. W. A. projects pursued at the New Jersey College and Station included clearing, draining, and fencing cut-over land for pasture and cultivation at a cost of about $60,000, building a trunk sewer and making sewer connections costing about $32,000, and repairing and renovating college and station buildings at a cost of approximately $12,000.

About 60 acres of land was purchased for $7,500 for use by the New Mexico Station in its study of sugar-beet seed production and other research work in agronomy.

With C. W. A. cooperation the Oklahoma Station completed a greenhouse of four sections, each 33 by 100 feet, with a total of approximately 14,000 square feet, at a cost of about $18,000, and improved about 2 miles of roads at an outlay of about $2,000.

The Mushroom Growers Cooperative Association of Pennsylvania contributed funds for an experimental mushroom-growing house at the Pennsylvania Station, in recognition of the successful research of the station in mushroom growing.

With the assistance of the C. W. A. and the National Emergency Relief Administration, the South Carolina Station constructed a building costing about $5,000 for use in making a land-use survey of the State and for other work in agronomy. A small greenhouse costing about $400 also was erected with station funds. At the Truck Experiment Station, near Charleston, improvements including minor buildings, a greenhouse, and a residence, valued at $5,000, were made with labor under the direction of the N. E. R. A. and the C. W. A. The Sandhill Experiment Station, under a similar arrangement, constructed a community building and auditorium and put in a permanent dam for a lake, at a total cost of $5,000. At the Pee Dee Experiment Station a foreman's residence, a barn, and a shed for storing machinery and grain, of a total value of $4,000 were con-

structed with C. W. A labor, and at the Coast Experiment Station a foreman's house costing $1,800 was built with N. E. R. A. labor.

The Tennessee Station, with P. W. A. funds, built a brick laboratory for work with cotton and corn at the central stations, and, with C. W. A. funds, a large tobacco barn and agronomy and livestock barns at the Tobacco Experiment Station at Greeneville.

The Texas Station reported the construction of minor buildings at the main station and at the substations at Iowa Park and Chillicothe; and the Vermont Station had the help of the C. W. A. in repairing and reconditioning some of its buildings.

At the Virginia Station an apple-packing house, with storage basement for grading and washing and the efficient handling of fruit from the experimental orchard, was erected at a cost of $5,400.

The Washington Station installed a refrigeration plant costing $8,500 and a greenhouse with automatic temperature control costing $7,500; and the Wyoming Station, with C. W. A. labor, made general improvements about the yards, barns, and irrigation ditches, amounting in value to $2,600.

RESEARCH PROJECTS AND PROGRAMS

As in previous years, the projects and programs of the stations included research into almost every phase of farming and rural life, including land use and conservation; crop adjustment; efficient and economical production, distribution, and marketing, and greater and better use of plant and animal products; improvement of the quality of farm products; protection against animal and plant diseases, insects, and other pests; betterment of the rural home and rural life; and tenancy, taxation, and other matters affecting the efficiency of farm business management.

Increased emphasis was placed on efficient and quality production and on the economic and social aspects of rural life essential to an effective program and policy of rural-life betterment. Station research continued to be profoundly influenced by active participation in various State and national recovery and readjustment activities of a more or less temporary and emergency character. The fundamental research which furnishes an essential basis for these activities was on the whole, however, well maintained, although with reduced personnel and inadequate financial support.

Of the active projects dealing essentially with fundamental research, 460 were supported with Adams funds and 1,578 with Purnell funds, as compared with 433 and 1,437, respectively, during the previous year. Of the Adams projects 52 were new and of the Purnell projects 284 were new. The increased number of active and new projects is one evidence of attempts of the experiment stations to adapt their research programs to emergency and adjustment problems.

The Adams and Purnell projects were distributed by major objectives and allotment of funds as shown in table 3.

TABLE 3.—*Distribution of Adams and Purnell projects by major objectives*

Item	Projects		Amount expended 1933–34	
	Adams	Purnell	Adams	Purnell
Improvement, more economical production, and better utilization of plants and plant products:				
Improving quality, disease resistance, and hardiness by breeding	*Number* 49	*Number* 90	$83,385	$167,846
Protection against insects, plant diseases, and rodents	145	218	174,030	278,258
Conservation, maintenance, and management of the soils and crops	75	264	124,026	497,199
Improved methods of producing, handling, storing, utilizing, and marketing of plant products	21	134	25,555	221,834
Physiology of growth and fruiting	45	51	82,841	90,022
Improvement, more economical production, and utilization of farm animals and animal products:				
Development of improved animals by breeding	14	30	19,007	45,050
Feeding and management for more economical production	43	203	101,711	447,551
Protection against diseases, parasites, and poison plants	48	72	79,070	116,209
Efficient production, processing, handling, and marketing practices	12	119	13,993	217,194
Physiology of growth, reproduction, and milk flow	7	23	15,005	29,394
The betterment of the family, the home, and the community:				
Physical improvement of the family through new knowledge of food composition, improvement in food preparation, analyses of dietary practices, development of new standards, and fundamental discoveries concerning factors affecting growth, nutrition, and health	1	96	1,659	153,131
Betterment of the home through information on household equipment and its arrangement and efficient use, factors affecting the selection and care of clothing and textile fabrics, methods and standards of household buying, consumption habits and standards, possibilities of contributions of homemakers to family income, and factors determining standards of living in various sections of the country	----	60	----	106,148
Social organization and improvement	----	44	----	66,541
Population movement and changes	----	8	----	11,453
Farm business improvement:				
Taxation	----	37	----	77,717
Land utilization	----	27	----	56,830
Financial relationships—tenancy, mortgages, investments, adjustments	----	24	----	34,813
Business organization and cost	----	57	----	130,692
Marketing organizations	----	21	----	35,751
Total	460	1,578	720,282	2,783,633

Classified with reference to technical fields covered, the Adams and Purnell projects were distributed as shown in table 4.

TABLE 4.—*Distribution of Adams and Purnell projects and funds by major technical subjects*

Subject	Adams projects		Purnell projects	
	Number	Funds [1]	Number	Funds [1]
Plant physiology	24	$48,062	21	$41,865
Soils and fertilizers	57	90,365	89	186,925
Field crops	21	34,412	99	173,496
Pastures and ranges	8	16,600	28	38,603
Horticulture	34	63,459	130	210,279
Forestry	4	7,425	5	7,560
Entomology and zoology	61	57,884	113	155,033
Plant pathology	83	106,544	109	126,937
Genetics:				
Plant	35	53,281	28	55,544
Animal	14	21,507	20	31,112
Animal production	45	108,715	231	451,992
Dairying	11	10,343	30	37,785
Animal diseases	42	64,820	59	97,499
Agricultural chemistry and technology	12	20,601	18	29,249
Agricultural engineering	4	8,709	62	94,069
Agricultural economics	----	----	336	709,331
Rural sociology	----	----	60	104,889
Home economics	5	7,555	140	231,465
Total	460	720,282	1,578	2,783,633

[1] Does not include allotments from other than Adams and Purnell funds.

COORDINATION AND COOPERATION

Many factors may play a part in determining the character and completeness of coordination necessary to produce the best results for a given research. Specific problems for solution may involve both a local or regional factor and the factor of time to influence or modify the plan of attack when viewed in a national way. A State or the Department may need to undertake research in connection with a primary function essentially regulatory in character. The extent to which such research can be coordinated with similar research elsewhere may be limited by the purpose and by the need for quick action. Local or national research to adapt findings of a fundamental character for wise application under particular conditions likewise may have only limited possibilities for coordination and cooperation. Even granting that effective coordination of research effort is of primary importance, organization and coordination are not ends in themselves. Care is necessary that they be not overemphasized to the point of diminishing returns from a given research.

The need as well as the opportunities for coordination and cooperation between the State experiment stations and the Department were greater during the year than in any other similar period in the history of these institutions. It is safe to say without reservation, also, that there was more effective coordination and cooperation than in any other similar period. This applies not only to coordination and cooperation in research, but to more effective use of accumulated findings from research, physical plant facilities, and research staff.

Coordinated research involving cooperation of an individual State station and a bureau of the Department would seem to have become a fully established procedure. Practically the entire research program of some bureaus and of major research divisions is conducted in cooperation with State stations. During the year 685 formal cooperative undertakings involving 760 separate agreements in which the Department of Agriculture and the State stations cooperated were on record. Approximately 70 percent of these were concerned for the most part with individual project investigations. The total number is 5 percent fewer than during the previous year. The decrease was due in part to reduction of funds for support of research, and in part to completion of some phases of cooperative studies and the need for concentrating on emergency problems not so suitable for formal cooperative research. In part, the decrease is due to continuation of efforts to consolidate and broaden cooperation on a regional and national basis rather than on the basis of an individual State and the Department, where such consolidation is desirable.

The number of cooperative studies per station ranged from 1 to 44. Subjects under cooperative study covered the entire broad field of agricultural and rural-life problems. Emphasis was shifted somewhat to include more studies pertaining to soil resources and land use, including soil surveys, development of pastures and forage, types of farming, and the prevention of soil losses through erosion.

The cooperative studies were distributed by subjects as follows: Improvement of quality and lowering cost of production of cereal, forage, textile, and other field crops, fruit and truck crops, improvement of pastures and ranges, and combating crop-plant diseases,

306 as compared with 304 the previous year; agricultural economics, developing sounder and more businesslike farm management, and bettering rural living conditions, 107 as compared with 127; improvement of animal products, especially meats, combating animal diseases, and improving the breeding of animals, 76 as compared with 82; soil surveys, improvement of soil fertility and productiveness, and fertilizer development and improvement, 67 as compared with 62; combating insect pests of plants, animals, and human beings, 67 as compared with 75; introducing greater efficiency and economy into agricultural-production operations by developing and adapting engineering principles, 59 as compared with 65; improvement of dairy stock and products and introducing economy into dairy-commodity production, 35 as compared with 37; improvement of timber crops, combating forest-tree insects and diseases, and forest maintenance, management, and reseeding, 28 as compared with 29; improvement of human foods and of food-management practices, 8 as compared with 13; maintenance of economically important wildlife and combating animal pests, 5 as compared with 5; and studies of weather conditions important to agriculture, 2 as compared with 3 the previous year.

A study of the coordination and cooperation in research under way during the year indicates an increase in the number of investigations of regional or Nation-wide scope. The following examples are significant of important developments along this line.

Reliable information on a Nation-wide basis was needed as to farm-mortgage foreclosures, tax delinquencies, and land values. As a part of the C. W. A. program, the Department of Agriculture, through the Bureau of Agricultural Economics, was provided with funds to undertake such a study. To accomplish the ends sought within the time limits, a coordinated effort involving the trained workers and the experience of the Department and each of the State stations was imperative. Arrangements were made essentially by telegraph, so that each of the 48 State stations entered immediately into cooperation with the Bureau of Agricultural Economics, furnishing the best leadership available, and the study was carried out. In addition to the information of Nation-wide scope and significance, the individual States collected supplemental facts as a foundation for further study to develop programs consistent with the State and local conditions and problems. This case illustrates the possibility of quick action in a coordinated effort involving the Department and all State stations on a basis effective both as to the national aspects and the State and local aspects of the problems under consideration.

The program to further pasture and forage development consistent with national and State programs for crop adjustments and land use illustrates a somewhat different type of coordinated effort. Bureaus of the Department coordinated their efforts on phases which appeared of national significance and application and turned to the individual States for a coordinated effort of the research and extension service staffs in developing State and local programs consistent with the national program as far as practicable. Without great formality facts and available assistance were pooled and every effort was made to assure the functioning of national and local agencies, each in its proper capacity.

From a research standpoint, perhaps one of the most outstanding efforts of planning coordinated research of this broader scope has been the cooperative Federal-State work on a cotton-research program. Research concerned with commodities such as cotton covers a field of tremendous scope from production to ultimate consumption and involves many agencies from the individual farmer to the industrial organization. The bureaus of the Department in their work on this problem have disregarded bureau and organization lines. Stations of the cotton-growing States have participated in this task. The end product to date is perhaps not what it will be ultimately, but the effort marks a step forward in this important field of planning coordinated research on a broader basis.

A beginning was made along another line of coordination. The Department's Bureaus of Agricultural Economics, Animal Industry, Dairy Industry, Plant Industry, Chemistry and Soils, and Agricultural Engineering, with the Office of Experiment Stations acting somewhat as a local representative for State experiment stations, gave consideration to a program for research relative to hay and hay products. The objectives were outlined and submitted to all the directors of State experiment stations. There was prompt response from all stations where hay and forage are important crops, indicating a desire to participate through coordination of their respective researches in this field. The directors of 28 stations indicated a desire to participate in such a project. When developed, the coordinated efforts on this subject should be productive and decidedly worth while.

Other examples might be given, but the foregoing are sufficient to indicate both the trend of development and the opportunity to expedite accumulation of facts needed on a national scale through cooperative effort involving the established State-Federal agencies for agricultural research reaching into every State.

Considering the varied conditions under which the stations must work and the wide field of their activities, there is little unnecessary duplication. There are of necessity many examples of repetition and verification under varying environmental and economic conditions, as well as a large number of local and emergency services which are essential to the full establishment and useful application in practice of the results of scientific research.

RECOVERY AND READJUSTMENT ACTIVITIES

The foregoing statement presents briefly the cooperation and coordination in the more formal research projects. In addition, the many less formal activities of the State stations in relation to recovery and readjustment in agriculture merit mention as a part of a report on the work and expenditures of these agencies. The following excerpt from the Report of the California Agricultural Experiment Station, under date of July 1, 1934, would apply reasonably well to each of the State stations:

> During the past two years, in the face of curtailed facilities, necessitating reduction in personnel and in the tools of agricultural research, the College of Agriculture and all of its divisions have responded to a larger number of requests for aid and service to California agriculture than ever before in the history of the institution. Such service and assistance have been rendered, not only to producers of raw farm products in California, but also to manufacturers, processors, handlers, distributors, and financing agencies of both raw and finished agricultural goods and commodities.

Additional complex problems arising out of the economic condition of American agriculture as a whole, and created in large part by the distressed conditions of American industry, have made the responsibility of the College of Agriculture much greater during the past two years than ever before. Upon many of these problems the College of Agriculture has worked and is working in cooperation with the United States Department of Agriculture, the Agricultural Adjustment Administration, the Farm Credit Administration, the United States Department of Interior, the Federal Emergency Relief Administration, and numerous other Federal and State institutions, organizations, and agencies ministering to the needs of agriculture.

State support from all sources for the stations was 12.2 percent less during the fiscal year 1934 than in the previous year, and approximately 27.5 percent less than for the fiscal year 1931. At the same time there was uncertainty in the first half of the year as to whether the Federal grants for the station work would be reduced by 25 percent. These reductions in and uncertainties regarding funds were offset to some extent by funds made available through recovery agencies. In considerable part, however, the demands for service in the way of information, consultations, and special undertakings were met as an emergency load, which would be physically beyond individual staff members for an extended period.

Incomplete reports from 41 of the State stations before the major drought activities began show for the year that a total of 587 major staff members of the stations had undertaken special assignments in connection with emergency activities and programs. These included assignments such as the presidency of Federal land banks, chairmanships of State planning boards, regional, State, or local leadership of national recovery activities, and participation in various ways in many research studies of emergency character.

Of the 587 members of the station staffs taking part in recovery activities, 72 were engaged in the Federal Civil Works Administration study, supervised by the Bureau of Agricultural Economics, relating to farm-tax delinquencies, farm-mortgage foreclosures, and farm-land values; 42 in studies of subsistence homesteads and part-time farming in cooperation with the Department of the Interior; 34 in studies of land uses and land-use policies in cooperation with the Agricultural Adjustment Administration, the Civil Works Administration, the Federal Emergency Relief Administration, and the State emergency relief administrations; 94 cooperated with the Farm Credit Administration in activities relating to land-bank and credit policies and administration; 40 with the Bureaus of Home Economics and Agricultural Engineering and the Civil Works Administration in the National Farm Housing and Rural Electrification Surveys; 90 with the Agricultural Adjustment Administration in the control of production of agricultural commodities; and 54 with the Bureaus of Agricultural Engineering and Chemistry and Soils and with the Forest Service and the Soil Erosion Control Service of the Department of the Interior on the control of soil erosion. In addition, 18 were engaged on drought-relief activities, 18 cooperated with the Tennessee Valley Authority on studies of fertilizers and soil-erosion control, and 37 cooperated with Special State agencies dealing with emergency recovery activities.

Other national activities of the Civil Works Administration, the Agricultural Adjustment Administration, the Federal Emergency Relief Administration, and other national recovery agencies occu-

pied all or part of the time of 187 major staff members of the stations on studies such as those on farm prices, marketing of farm products, rural social betterment, and the control of insect pests and diseases of plants.

Naturally, the more fundamental research was curtailed. On the other hand, the emergency activities provided the research agencies with valuable data for future analysis and interpretation, and perhaps with a broader conception of the complex problems to be met by means of their research.

RESEARCH AND SERVICE

Speaking of the basic necessity for scientific research, the Secretary of Agriculture said in his annual report for 1934:

> Research is the Department's biggest job; indeed, research is the foundation of everything it does. It could not help farmers to plan their production, to reduce their costs, to fight the diseases and pests that attack animals and plants, to produce better crops and livestock, and to market their products efficiently, without first studying how these things may be done.

The fund of knowledge and information accumulated through research by the State experiment stations and the Department during the past half century has been drawn upon heavily during the present depression. The national programs of agricultural adjustment, erosion control, land planning, and rural rehabilitation have had need of all specific information available. In addition, these and other programs are taxing the facilities of research agencies for additional facts.

As indicated under the discussion of coordination elsewhere in this report, approximately 600 station staff members undertook special assignments during the year. This fact, and the numerous and urgent calls upon the stations for information, and upon staff members to serve in advisory capacities, emphasized the important service rendered by the State stations in cooperation with the Department of Agriculture. Writing on this point, the director of the Wyoming Station in a recent communication makes the following statement, which is equally applicable to other stations:

> These experts are an alert group trained in the methods of research, habituated to hunt for facts pertinent to agricultural problems, and imbued with the idea that their highest duty is unselfish, wholehearted, and loyal service to the State and Nation. They not only have facts which are directly pertinent to the projects upon which they are working, but in addition they have acquired large amounts of other information as a byproduct of their research. Sometimes in this byproduct are the facts that are needed to help in the working out of some emergency problem. Because they closely follow the work of their colleagues all over the world and keep up with the progress of science in general, their knowledge has gone far beyond what they have gathered in the work on the small number of projects to which they have been confined in the experiment stations. As a result it sometimes seems that in evaluating the work of the American system of experiment stations great weight must be given to the fact that in addition to keeping this large group of scientists at work on specific projects, it has enabled the Nation to build up and maintain, scattered throughout the Nation, a corps of scientific experts which can be readily mobilized to solve the problems of any emergency.

The events of the past year and the unusual demand on the time and energies of the research specialists have served to emphasize as never before in peace times the point made in the quotation above from the report of the Secretary of Agriculture, that research is the

basis for help to farmers in planning and production, reducing costs, fighting diseases and pests that attack animals and plants, and in all other problems pertaining to agriculture and rural life. It has also emphasized the need and advantage of an alert and broadly informed personnel ready at all times to mobilize its extensive resources of exact knowledge and sound judgment for the common good.

SOME RESULTS OF RECENT STATION WORK

LAND USE

The agricultural experiment stations are making important contributions to the national program of better conservation and use of natural resources in many ways, but particularly through soil surveys and land classification, protection of land from erosion and other destructive agencies, study of soil fertility and crop adaptations, and development and better use of water supplies, all directed toward the highest and best agricultural use of the natural resources. A few significant and pertinent examples of such work are cited in the following pages.

Rating the productive capacity of soils.—A score-card method of rating the productive capacity of soils, worked out by the California Station, should prove of practical value in selecting soils for different purposes and bringing about better use of the land, particularly where a large number of widely divergent soil conditions exist. In this method soils having the highest productive capacity, as shown by their study under field conditions, are rated at 100 percent, three general factors being taken into account, (1) character of the soil profile, (2) texture, and (3) modifying conditions. An index of productivity is derived from these three factors, the ratings and final index being expressed in percentages. By the use of this method a large number of divergent soil types can be compared, or various tracts of land can be compared from the soil standpoint.

A classification of Maryland soils from the standpoint of productivity had been proposed by the Maryland Station. In this plan the soil groups are arranged according to their relative agricultural value. Each group is given a numerical value on a State basis and in addition an intergroup value with and without fertilizers for each of the leading agricultural commodities. The data used were derived from soil surveys of the different counties, results of cooperative fertility and variety tests conducted on numerous farms in the State, and fertility surveys and observations over a period of many years.

Classification and use of mountain soils.—Studies by the Kentucky Station in the mountain section of eastern Kentucky, comparing 34 counties with a total area of 12,000 square miles and a population of 764,000, or nearly one-third of the total area and population of the State, showed the greater part of the area to be unsuitable for agriculture. There was found to be a marked disparity between this and the better agricultural sections of Kentucky in the resources which condition standards of living.

For more than a generation the people of this section have derived a great part of their incomes from nonfarming sources such as lumbering and mining. Since 1929 the opportunities for securing income

from nonfarming sources have largely disappeared. This lack of outside sources of income coupled with the small amount of good agricultural land per family has resulted in wide-spread poverty. During a considerable part of 1933 more than half of all families in the 34 mountain counties were accepting some type of relief. A factor which added materially to the difficulty of the situation was that many families which had previously gone out from the section to engage in mining and other industrial occupations were forced by the shutting down of these industries to return to the communities from which they had emigrated. This added a further burden to the already limited food-producing area and housing facilities.

The station concludes that families on the rougher, poorer land, most of whom now depend upon public relief, should have opportunity to develop as completely as possible land resources which will enable them to live where they now are, and, if removal is undertaken, this should be done slowly and on a voluntary basis. Industries should be encouraged to locate at various points, but programs for restoring farm families to a self-sufficient base in sections similar to those described should begin by making more useful the limited amount of potential tillable land. The steeper land should be devoted to the growing of trees, and the land of more moderate slopes, especially at the lower zones of the hillsides, should be seeded to meadows and pastures.

Classification of forest land.—The Michigan Station has attempted to classify the forest lands of that State on the basis of the character of forest growth, and has been able to identify the characteristic forest growth on different types of soil. The Connecticut (State) Station and the New York (Cornell) Station, and others, have done similar work.

Land-use planning in Missouri.—The Missouri Station has studied and defined the wide range of economic, sociological, and engineering data required for land-use planning in that State. Similar work on classification and evaluation of soils has been reported by the North Carolina and North Dakota Stations.

Selecting farm land in Oregon.—Appraising more than 6,000,000 acres of land, one of the principal resources in the State, so that the serious mistakes in the selection of land in the past may be avoided in the future is an accomplishment of the Oregon Station which has added wealth, protected investments, and decreased farm failures.

Land use in the Tennessee Valley.—A check-up on the crop-producing possibilities of the soils of the Tennessee Valley was started in Jefferson County, near Nashville, Tenn., to be carried on by the Tennessee Station and the United States Department of Agriculture, with the support of the Tennessee Valley Authority. The usual soil survey is to be supplemented with a detailed crop survey. These surveys will be used by the T. V. A. in planning agricultural use of land in connection with its general program of development.

Land use in Wyoming.—A report on soil investigations by the Wyoming Station of the La Prele irrigation project in Converse County points out and discusses areas which are low in fertility and high in alkali upon which cultivation should be abandoned and the more fertile areas to which farming operations should be confined.

Selecting cotton soils.—On the basis of the 1934–35 cotton acreage reduction contracts, the Arkansas Station made a map of the 5-year

average cotton production of that State, which shows the low- and high-producing areas. Other studies by the station have shown the relationship between farm income and soil type. This information it is thought will contribute greatly to localizing areas of low productivity and be of value in the Federal program of land utilization and land planning.

Efficient use of cotton lands.—The Texas Station has recently reported results of investigations which show that substantial economies in cost of producing cotton can be effected in the western Cotton Belt by the judicious selection of land and by supplementing cotton production by meat and milk production.

Recreational use of idle land.—Greater recreational use of land not fitted to agriculture is recommended by the Connecticut (Storrs) Station, which outlines plans for better present and future use of lands in that State.

The use to which the idle lands of the northern part of the Lower Peninsula of Michigan have been put, in the way of summer resorts, summer homes, summer hotels, State parks, boys' or girls' clubs, and hunting and fishing clubs, has been studied and reported upon by the Michigan Station. Increased contributions to public support through the payment of taxes is one of the most tangible results of such improvements. The conditions under which these summer communities may succeed and the possibilities of successful use of the lands are pointed out.

Use of Minnesota cut-over lands.—A study of land use in northern Minnesota by the Minnesota Station has resulted in the districting of the cut-over area in accordance with physical and economic factors which is supplying guidance in developing marginal land purchase programs. This districting marks an initial step in land classification and is basic to classification and zoning which are expected to follow. Information on public expenditures and services in the area points to possible reorganizations and economies which may be effected. Studies of isolated settlers and settlements showed costs involved and the need for concentration of settlement. Farm-management records were secured which throw light on farm returns under favorable and unfavorable land-use situations. Records of part-time farmers indicate the possibilities and limitations of this type of development.

Land-use policy in South Carolina.—Proceeding on the assumption that a definite land policy is basic to a sound agricultural policy, the South Carolina Station, cooperating with the C. W. A. and F. E. R. A., is assembling information as a basis for wise land planning. A study now under way furnishes detailed information as to the soil type, soil reaction, topography, degree of erosion, and crop history of every farm in the State. A social and economic study has also been made in eight representative localities of the State for the purpose of securing definite information on farm organization and management and other economic and social factors important in land planning. The agronomic, soil, chemical, horticultural, and economic researches of the station during the past years furnish a background for these special land-use studies and together they provide a very sound basis for land planning. Besides furnishing basic material for land planning on a regional, State, and national basis, these studies furnish concrete information upon which recommenda-

tions are made to individual farmers as to the best use for different parts of the farm and for soil-improvement, rotation, and fertilizer practices. A report is made to each farmer in the State giving full information and recommendations covering these points.

Use of hill-town lands in Vermont.—Studies of land use and related problems in hill towns of Vermont, representing conditions of meager physical resources, sparse and declining population, and limited public facilities and services, have recently been reported by the Vermont Station, with suggestions and recommendations as to how conditions may be improved. A plan of land use which would limit farming and population to lands best suited to agricultural purposes, combined with improvement of forested areas and increased recreational use of land, is proposed. Greater development and use of water-power resources are also suggested.

Use of range lands.—Studies reported by the Wyoming Station show the balance between land, labor, and equipment necessary to determine the size and set-up of units that will be required for permittees for grazing on the national forests and on the public domain under the Taylor Act. Much of the information is also fundamental in the study of the problem of the retirement of submarginal lands.

SOIL EROSION

Many of the experiment stations are active in finding effective means of reducing the enormous losses caused by soil erosion and run-off of surface waters.

Cover crops and strip cropping to control soil erosion.—Terracing is usually considered the first step in successful erosion and run-off control but the use of winter cover crops and strip cropping have also been found by the Alabama Station and others to be effective for this purpose. Vetch which proved superior as a winter cover crop to all other crops tested by the Alabama Station, was much more effective than rye as a soil-protecting crop.

Strip cropping with alternate 20-foot strips of cotton and soybeans was found by the Alabama Station not only to aid in erosion control but to supply needed additional hay. It also reduces the cotton acreage and is thus in line with the national cotton-reduction program.

Sod-forming crops such as clover, alfalfa, and bluegrass have been found by the Iowa Station, cooperating with the Department of Agriculture, to be very effective in preventing run-off and soil losses on Marshall silt loam. Strip farming, using corn and alfalfa, and rotations including oats and clover, reduced erosion materially. The use of rye or rye and vetch as winter cover crops protected the land from washing. Contouring corn land was effective in preventing run-off. Farm manure and green manuring with sweetclover reduced erosion and at the same time increased the yield of corn.

Control of wind erosion.—The recent drought in the west was accompanied by unprecedented dust storms and erosion of bare soils. As a result of previous work the South Dakota Station was able to give farmers useful advice with regard to control of soil blowing and erosion. Preventive and protective measures suggested included (1) plowing of cross furrows and (2) planting of emergency crops which might arrest wind velocity and could be plowed under later to supply needed organic matter.

Terracing.—Terracing to prevent soil erosion, which is stated by the Illinois Station to be the greatest cause of loss of fertility on 26,000,000 acres in that State, is now practiced on 16,000,000 acres and is being gradually extended to other lands subject to erosion. The station has been very active in demonstrating and spreading information regarding the best methods of terracing.

The use of terraces for the dual purpose of preventing erosion and conserving the water supply has been continued by the Texas Station with increasing success. It is estimated that over 1,000,000 acres in 174 counties of the State are thus being protected.

A new type of machine for building terraces is being developed by the Iowa Station and gives promise of being an important factor in the conservation of soil resources by the terracing method. This machine throws the soil into place instead of pushing it as does a blade grader or carrying it as does an elevating grader. The machine is much simpler for a farmer to use and operate than the conventional machines now used.

A new terracing tool, which has been adopted for use in erosion-control work by the Department of Agriculture and the Department of the Interior especially in the grain belt, has been devised by the Missouri Station. In field tests "in which the machine was drawn by a 15–30 kerosene-burning tractor, it built standard broad base terraces at an average rate of 100 feet of terrace in 10 minutes 50 seconds. The average cost per 100 feet of completed terrace, 19 feet wide at base, with 10-foot water channel and crest of ridge 26 inches high, was 25 cents, this covering the cost of operating the tractor and the wages of the driver."

WATER CONSERVATION AND USE

Determining the need for irrigation.—The wilting-stage method of determining the need for irrigation has been successfully applied to prune orchards by the California Station, which has shown that applying water to a prune orchard shortly before the moisture content of the top 6 feet of soil is reduced to the permanent wilting percentage is good irrigation practice.

Forecasting and increasing water supply.—Further progress in snow surveys as a means of predicting possible water supply was reported during the year by the Nevada and Utah Stations. The methods of surveying snow cover and predicting possible water supply have developed to a high degree of practical utility. For example, a water-supply forecast, based on results recorded by the Utah Station during the past 10 years, indicated that in 1934 the State would suffer a water shortage as low as 25 percent of normal in some streams but no more than 50 percent in others. Convinced of the accuracy of this forecast, a grant of $600,000 was secured from the Utah Emergency Relief Administration to develop springs, water holes, and other supplementary sources of water supply. As a result of previous studies by the station of locations of underground water, well logs, pressure heads, and the like, it was possible to expedite this work with a high degree of intelligence and accuracy. Thus, before the drought really had been felt, Utah was preparing for it, a step which proved invaluable as the season advanced and drought became acute.

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Utilizing road-ditch water.—The Texas Station has shown that surplus water in road ditches can be diverted to farm lands and thus made to reduce the cost of producing cotton and at the same time benefit the highways. Moreover, this recapture and use of run-off water tends to withhold surplus waters from streams, thus lessening flood damage in lower areas. Its general use on farm lands is considered good farm practice and good public policy.

PLANT PRODUCTION AND PRODUCTS

A large part of the work of the experiment stations deals with improvement in plant production and plant products and the wider and better use of the products. This is in recognition of the fact that efficient and remunerative production is basic to the economic and social adjustments necessary to improvement of rural life.

General

Simple soil tests.—Simple rapid tests of soil fertility serve many useful purposes as supplements to more elaborate and time-consuming laboratory and field studies. Many such tests have been developed by the experiment stations and are being used with good results. Some recent developments in this line are rapid methods of determining available phosphoric acid in soils, proposed by the Illinois and Rhode Island Stations, and of testing soils for nitrates, phosphorus, manganese, potassium, magnesium, aluminum, chlorides, sulphates, calcium, iron, ammonium, and nitrites proposed by the Michigan Station.

Minor soil deficiencies.—Serious disturbances of plant growth frequently result from deficiencies (or excesses) of certain usually minor soil constituents. For example, it was observed by the South Carolina Station that the fact that the gray sandy loam soils of the State can be farmed successfully at a higher acidity than the red to brown soils is very probably closely related to the amount of iron, manganese, and other minor plant nutrients present in the soil. The gray Coastal Plain soils particularly contain a relatively small amount of minor nutrients, such as manganese, iron, and magnesium, which thus often become the limiting factors in plant growth. The addition of these minor nutrients to some of the truck soils has produced a marked improvement on the growth of crops. High acidity in the red soils often results in bringing toxic amounts of such materials as manganese, aluminum, and iron into solution, and in such cases it is often necessary to add lime before the soils can be farmed successfully. Basic slag has been found to be a very satisfactory soil amendment on some of the lower Coastal Plain truck soils, probably because of the large number of minor plant nutrients it contains.

Chlorosis, or loss of green color in plants, and similar disorders have been definitely associated with deficiency of iron, manganese, or magnesium in the soil, particularly in presence of excess of lime or other alkaline substance.

Disorders due to iron deficiency and similar causes, the Arizona Station finds, may result from continued use of alkaline irrigation water on alkaline calcareous soils, and suggests that the trouble may

be mitigated by acidifying the irrigation water. The Texas Station has shown that the injurious effects of iron deficiency in the soil may be reduced by applications of sulphur and manure supplemented with iron sulphate applied as a spray (1 pound of iron sulphate to 3 or 4 gallons of water).

Manganese chlorosis, the Rhode Island Station finds, may readily be corrected by use of varying but relatively small amounts of manganese sulphate, 8 to 30 pounds per acre depending upon the severity of the condition, applied as a spray or mixed with fertilizer. The trouble may be avoided by maintaining a soil acidity which keeps the soil manganese available to the plant. Applications of manure have been found beneficial for this purpose.

Meeting a seed shortage.—At the beginning of the season of 1933 there was a shortage of supply of all kinds of seed in the hands of farmers, which shortage was increased by the fact that supplies of seed of all staple crops had already been closely utilized. It was necessary, therefore, for the people of South Dakota, for example, to purchase seed from outside sources for very much of the area of the State. The South Dakota Station was able to supply information on an organized basis for determining the right kind of seed of corn, wheat, oats, barley, flax, and other crops, because it has continuously made tests of varieties and developed new strains of crops adapted to the conditions of the State.

Fractional application of fertilizers.—In a study of the effects of varying applications of superphosphate applied at different times in a 4-year rotation of corn, corn, oats, and clover on drift soil, the Iowa Station found that over a 10-year period the superphosphate applied once in the rotation at the rate of 240 pounds per acre gave better results than the same total amount per rotation applied in three applications of 80 pounds each per acre, and better results than 480 pounds so applied.

Need of phosphatic fertilizers.—The Arizona Station has found widespread need of phosphatic fertilizers on the alkaline soils of that State, the alkalinity of which is being constantly increased by use of irrigation waters carrying a relatively high percentage of alkali salts. A suggested corrective is reduction of the alkalinity of the irrigation water by adding sulphuric acid.

Certain soil areas in Montana have been shown by the Montana Station to be so deficient in phosphorus as to impair both plant and animal nutrition, in the latter case resulting in the pernicious habit of bone chewing. This station also found that not only the yield but the phosphorus content of forage plants grown in these areas can be increased by the use of phosphatic fertilizers.

On many Vermont soils phosphoric acid applied as fertilizers is fixed in more or less unavailable forms, the Vermont Station finds. When farmyard manure was applied with the phosphate the availability of the phosphoric acid was increased.

Floats, a very finely ground soft raw rock phosphate, has been found by the New York (Cornell) Station to be somewhat more efficient than superphosphate in increasing the yields of corn and small grains on silty clay loam and silt loam soils when used at the rate of 2 pounds of the former to 1 pound of the latter.

Limestone as a fertilizer.—The Iowa Station found that 300 pounds per acre of 40-mesh limestone drilled in the row with alfalfa was

not so effective in establishing the crop as quarry-run limestone applied broadcast the previous fall in an amount sufficient to meet the lime requirements of the soil. It was observed that the application of limestone also increased the development of alfalfa and red clover root-nodule bacteria in the absence of the host plant, thus indicating the advantage of not allowing the soil to become acid in the period between the growing of the legume crops of the rotation.

A complete change, due to the findings of the Missouri Station, in the use of agricultural limestone in the growing of legumes is effecting a great saving in the cost of liming in that State. The station concludes that the primary function of limestone is to furnish calcium as a nutrient rather than merely to neutralize the acidity of the soil. From 300 to 500 pounds of finely pulverized limestone per acre has been found to secure approximately the same results as were formerly obtained with 3 tons of somewhat coarser material. The use of finely ground lime is increasing rapidly and farmers are getting good stands of legumes with much smaller applications than was formerly considered necessary.

In view of the fact that manufacturers of fertilizers sometimes use materials which increase the acidity of certain already acid soils and thus reduce yields, the Alabama Station suggests the use of limestone as a fertilizer filler in place of sand, now commonly used, as a means of overcoming the difficulty and increasing benefits from the use of fertilizers on acid soils.

Crop succession and rotation.—The marked influence of crops on those immediately following on the same soil has been shown in experiments extending over many years at the Rhode Island Station. In experiments recently reported, timothy produced the highest yields following onions, rye, and oats, and the lowest yields following rutabagas and timothy. Rutabagas and mangels gave especially low yields following themselves. Mangels following buckwheat were also reduced in yield. Lettuce grown as a late crop gave better growth following potatoes and beets than following peas or cabbage. Spinach produced the highest yield after potatoes and lowest following peas. Buckwheat yielded less following itself than following rye or redtop.

By simply changing the order of a four-crop rotation from corn, potatoes, wheat, and clover to potatoes, corn, wheat, and clover, all other conditions being the same, the cash returns were increased 24 percent, in experiments reported by the Ohio Station.

Insect-resistant crops.—One of the most promising recent advances in crop protection is the breeding of plants resistant to insect attack. The Kansas Station has distributed to farmers two crop varieties which repeated tests have shown to be resistant to insect attack—Atlas sorgo, resistant to chinch bugs, and Kawvale wheat, which has proved very resistant to the Hessian fly.

Prediction of insect outbreaks.—Prediction of insect outbreaks has been one of the greatest services rendered by some of the experiment stations to farmers in areas subject to sudden and devastating outbreaks of insects. For example, on the basis of experimental work, the Montana Station, in cooperation with the Department of Agriculture, has been able to give such advanced notices concerning grasshoppers and cutworms and has attempted a similar service with the

beet webworm. Other stations, cooperating with the Department of Agriculture, have done similar work. An electric insect trap, devised by the Massachusetts Station, not only kills insects but indicates the prevalence of different insect pests and hence when to spray.

Grasshopper control.—Grasshopper control has claimed attention of a number of stations in areas where outbreaks of this insect may become a serious menace. Recently the Colorado Station has proposed an improved grasshopper-poison bait consisting of amyl acetate and beet molasses, with dried beet pulp in place of bran commonly used.

Crop plants found to be resistant to grasshopper attack (p. 30), the South Dakota Station finds, are being grown extensively by farmers in that State to lessen loss from this cause. The station has also worked out effective cultural methods of controlling this pest, in addition to the use of poison-bran bait. With regard to baits, the station finds that amyl acetate and fruit juices are not necessary and contribute nothing to their attractiveness, and that while wheat bran is considered the most effective carrier of the poison in the bait, substitutes such as ground oat chaff and sawdust of trees other than evergreens may be used.

Chinch-bug control.—In anticipation of a serious outbreak of chinch bugs, especially in the area from Nebraska to Ohio and from Oklahoma to Michigan and Minnesota, as a result of the excessive drought and heat of the past season, the stations in this area, in cooperation with the Department of Agriculture, were especially active in studying hibernation as a basis for devising emergency control measures and are thus better prepared to cope with the menace. The Illinois Station has shown how to combat this pest by growing crops on which the chinch bug does not feed, adjusting rotations, planting varieties of corn that are relatively resistant to chinch-bug damage, and building effective barriers to prevent the bugs from invading fields of corn. The Ohio Station found that creosote can be diluted from one-half to two-thirds with crude oil and still prove to be a fairly efficient barrier to chinch bugs. (See also p. 30.)

Pastures

Experiment stations in States having or likely to have extensive areas of idle lands are actively engaged, to a large extent in cooperation with the Department of Agriculture, in trying to find the most economical ways of improving such lands and utilizing them for pasture purposes. Much has been accomplished in the improvement, management, and use of pastures. In fact, almost every phase of this complex subject has been or is being investigated.

Soil-protective value of pastures.—The high protective value (against erosion) of grass as compared with cultivated crops has been strikingly demonstrated by many of the experiment stations, as well as the Department of Agriculture. For example, it has been shown that land in cotton planted on a 7-percent slope in Oklahoma or Texas may lose annually from 14 to 17 tons per acre of the best topsoil, but that land in grass suffers an annual loss of only 0.04 to 0.5 ton per acre. Similar results have been reported from Kansas, Missouri, North Carolina, and other States. The Missouri Station has obtained results indicating that terraces may be unnecessary on lands in grass.

The value of grass cover for conserving moisture as well as preventing erosion has also been demonstrated.

Plantings of lespedeza on waste hill lands which have been subjected to erosion for a number of years were shown by the North Carolina Station to reduce erosion and to furnish enough grazing to pay the cost of seeding.

Fertilizing pastures.—Excellent pastures, the Alabama Station finds, may be produced in many parts of that State, especially where phosphate, lime, and suitable mixtures of seed are used. In the Black Belt, phosphate applied annually has resulted in the production of a pasture that is more profitable than cotton at the rate of 1 bale per acre.

Application of fertilizers accentuated the spring flush but did not increase materially the number of grazing days during the dry period of July and August, in experiments reported by the Delaware Station.

Use of nitrate fertilizers, the Florida Station found, increased the growth of vegetative parts of grasses high in protein, prolonged the growing period, and increased the carrying capacity of pastures. It was thus possible to obtain a greater quantity of more succulent, palatable, and nutritious feed, if the pasture were grazed sufficiently to stimulate and prolong the vegetative growth. Fertilizing increased the yield of dairy pastures in some instances as much as 95 percent.

Nitrogen fertilizers were found by the New Hampshire Station to have greater influence on the yield of timothy grown on neglected grassland than other fertilizers tested. In a dry year there was universal response to nitrogen in top-dressing old pastures. Phosphorus influenced the yield markedly the first year, and lime was also beneficial.

Although the permanent grasslands of New Jersey yield a surprisingly large amount of feed despite their general neglect, the New Jersey Station has shown that the amount and nutritive quality of feed from such pastures may be greatly increased by moderate use of fertilizers, particularly nitrogen fertilizers (and lime on acid soils) and rotation grazing to insure that the cattle get the grasses in the younger stage of growth. The use of nitrogen fertilizers not only increased the earliness but prolonged the growth of the pasture grasses.

Fertilized pasture gave 3 weeks earlier grazing and a better quality and greater quantity of grass for late grazing than unfertilized, in experiments reported by the North Carolina Station. Based upon milk production or the replacement of purchased feeds, such use of fertilizers returned a small profit even under recent unfavorable market conditions.

Ground limestone, manure, and superphosphate have been shown by the Ohio Station to be especially effective in improving permanent pastures on a silt loam soil deficient in lime. Manure may be omitted without detriment except a slowing down of the effect.

Results of experiments by the Virginia Station on old sod bluegrass pastures favor incomplete as compared with complete fertilizers principally because nitrogen does not seem to be profitable. With the different methods of fertilizing, the prices per 100 pounds that milk

would have to bring to pay for rent and fertilizer in 1933 were as follows: Lime and phosphate 29.6 cents, lime and nitrogen 42.7 cents, and lime and potash 27.7 cents. The unfertilized pasture cost was 29.5 cents per 100 pounds of milk. These figures indicate the low cost of producing milk on pastures and also point to the fact that the price received for milk should determine the kind and extent of fertilizing.

On the cut-over pinelands of the Coastal Plain, methods proposed by the South Carolina Station have made it possible to produce excellent pastures in one season, where formerly 2 or 3 years were required to get a good sod. By correcting the phosphorus deficiency which normally exists on these soils the carrying capacity of lespedeza and carpet grass pasture was more than doubled. In the sand-hill section where permanent pastures are difficult to maintain, annual pastures composed of oats, barley, and vetch in winter, pearl millet for spring and early summer, and soybeans for summer and fall have provided grazing every day in the year, and dairy cows on full feed have harvested 72.2 percent of their total nutrients for the 12-month period from the pasture. In the Piedmont section fertilizer experiments have emphasized the need for phosphorus and potash in larger amounts than are commonly used. Where lime was used at the rate of 3,000 pounds per acre, with no other fertilizers, cows were grazed 210 days and secured nutrients from an acre of pasture equivalent to 3½ tons of alfalfa hay. Where 450 pounds of 16-percent superphosphate was applied in addition to lime, the grazing period was the same but the nutrients secured from an acre was equivalent to 4½ tons of alfalfa hay.

Pasture and range grasses.—Grasses and grass mixtures especially suited to different purposes and how they can best be used have been studied by many of the experiment stations and the Department of Agriculture.

Bermuda grass supplemented with legumes provided satisfactory grazing for beef cattle until July 1, in experiments reported by the Arkansas Station. The station suggests that such pastures may be used to advantage in livestock production to take the place of natural pastures of poor quality.

The value of Sudan grass as a means of supplying continuous pasture throughout the season has been demonstrated by the Delaware Station and others. This is an acute problem, especially on sandy soils, in many States, due to dry weather during July and August. The results of the Delaware Station experiments tend to show that Sudan grass pasture may reasonably be expected to carry one cow per acre from about July 1 to September 1 in normal seasons in Delaware.

Florida cattlemen have been enabled to increase the carrying capacity of their pastures from twofold to tenfold over the native grasslands as a result of the introduction and establishment of improved pasture grasses by the Florida Station cooperating with the Department of Agriculture.

Sweetclover pasture, the Idaho Station finds, may be improved by seeding a hardy variety of fall wheat in the sweetclover the first year. The wheat increases the value of the pasture since it is ready to use 2 or 3 weeks earlier in the spring than the sweetclover. It

also increases the total amount of feed, adds variety, and tends to avoid the danger of bloat on sweetclover pasture.

Redtop is stated by the Illinois Station to be the second most important pasture grass in the United States. The station further states that about 85 percent of the world's supply of redtop seed and 95 percent of the seed used in the United States is produced in southern Illinois. The station therefore undertook to show how production and quality of the seed may be improved, the cost of production reduced, and redtop-seed production adjusted with advantage to other farm operations and to the changed demand for the crop. The station says:

> The individual farmer's best opportunity to adjust his farming operations to the changed demand for redtop lies in so improving the farm plan that a part of the redtop seed acreage may be used for hay and pasture on the farm in livestock production, and so that the acreage cut for seed may be varied in response to market demands.

A mixture of oats and vetch, and barley, produced good winter pasture, and Sudan grass and soybeans proved to be the best for summer pasture for dairy cattle, in experiments reported by the Louisiana Station.

A marked shift from cereals to forage in Minnesota, especially increased use of sweetclover and reed canary grass (*Phalaris*) in place of run-down bluegrass pastures, is reported by the Minnesota Station, as a result of the work of the station extending over many years.

From a study of methods of improving and extending the area of bluegrass pasture, the Missouri Station, cooperating with the Department of Agriculture, concludes that returns from good bluegrass pastures are perhaps not exceeded over a long period by those from any other equal area in the farming system of the State. Improvement of permanent pastures and the extension of their area in the State are therefore considered important objectives of Missouri agriculture. Barley as a component of a year-around pasture system, including also bluegrass and Korean lespedeza, has been demonstrated by the station to be well suited to conditions in that State. It supplies both fall and spring pasture.

A seed mixture for permanent pastures, proposed by the New York (Cornell) Station and now widely used in that State, includes wild white clover, which the station has shown to have a marked influence on the growth and feeding value of grasses with which it is associated.

Eradicating weeds and brush from pastures.—Effective means of eradicating weeds and brush from pastures have been found by a number of experiment stations. The Kansas Station has shown that mowing at the blooming stage before seed has been formed is an effective means of eradicating weeds. Buckbrush and sumac were most effectively eradicated by cutting them in flower, about May 10 and June 8, respectively. The Connecticut (Storrs) Station has found mowing in July effective in eradicating various kinds of brush (soft maples, alders, white birches, blackberries, and others).

Burning of native pastures.—Continued annual burning of native bluestem pastures has been found by the Kansas Station to decrease the total production of grass. The station recommends, under certain conditions, burning in early spring after hard freezing weather is over and before the native grasses start to grow, preferably when the ground is wet. In experiments reported by the Wisconsin Station,

burning bluegrass pasture on frozen soil decreased production 71 percent.

Grazing woodland pastures.—Present methods of grazing woodland pastures in the Corn Belt were found by the Indiana Station to be inadequate to maintain the weights of animals over a 6-month season. Continued grazing as generally practiced lowers the capacity of the pastures and tends to eliminate the better forage plants. The timber-producing capacity is also gradually destroyed by repeated browsing.

Grazing in the national forests.—Information of value, relating to the problems of retirement of submarginal lands and determining the size and set-up of units that will be required for permittees for grazing in the national forests and on the public domain, was obtained in a study of range and ranch management reported by the Wyoming Station.

Deferred or rotational grazing.—Deferring grazing until about June 15 every alternate year has been shown by the Kansas Station to increase the grazing capacity of the pasture 35 percent, as compared with pasture grazed during the whole season, with an improvement of the nutritive value of the feed.

Adoption by dairy farmers, in whole or in part, of some form of pasture management involving systematic rotational grazing is recommended by the Wisconsin Station. The Washington Station, however, finds that rotation grazing alone, on highly productive pastures, does not pay for the extra costs involved nor result in an improved quality of pasture grass.

Use of pastures.—The value and best use of pastures and of various pasture plants handled in different ways for economical maintenance of farm animals of all kinds has been very thoroughly studied by the experiment stations cooperating in many cases with the Department of Agriculture. The Louisiana, Virginia, and West Virginia Stations, among others, and the Department of Agriculture have shown that beef and lamb of high quality can be produced on good pasture without grain while on grass.

The results of year-around pasture experiments by the Tennessee Station with dairy cattle showed that more economical milk production was maintained without the feeding of the usual concentrates than with them. The year-around pasture furnished the equivalent of 300 days of pasture. (See also p. 57.)

The feeding value of grasses cut at different stages and cured in different ways has been studied by the Arizona, Louisiana, Massachusetts, Nebraska, New Jersey, Virginia, and Wisconsin Stations, among others. The higher feeding value of young grasses as compared with matured grasses and the harmful effects of exposure to rain and other unfavorable weather conditions, excessive sunlight in natural curing, and too high temperature in artificial curing has been demonstrated. The Vermont Station has found grass cut every 2 to 4 weeks and artificially dried to be a highly nutritious concentrated feed for dairy cows.

Mineral deficiencies of pasture plants.—Disorders in livestock resulting from use of grasses and other forage deficient in mineral constituents or containing toxic mineral substances, and possible means of correction, have been studied by many experiment stations, including, among others, those of Florida, Minnesota, South Dakota,

and Texas, as well as by the Department of Agriculture. Salt-sick in Florida, lime and phosphorus deficiencies in Minnesota, so-called "alkali" disease (selenium poisoning) in South Dakota and elsewhere and loin disease in Texas are examples of such disorders. (See also pp. 71, 74.)

Poisonous pasture plants.—Studies of poisonous pasture and range plants and means of protection against them have been reported recently by a number of stations, including particularly those of Nebraska, Texas, and Wyoming. (See also p. 73.)

Field Crops

COTTON

High yields of cotton in Arizona.—Record yields, ranging from 3.38 to 3.76 bales per acre, of Acala cotton were obtained by the Arizona Station in 1933. Various irrigation treatments were given the plats, but the soil moisture was never allowed to drop closer than 1.5 percent to the wilting coefficient at any time during the growing season. The soil which produced such tremendous yields is a deep sandy loam kept in a highly fertile state through proper crop rotation coupled with livestock farming. No commercial fertilizers had ever been applied to the land.

Selection and care of seed cotton.—In a study of the relation of changes in a standard cotton variety of known origin and quality to care in handling of seed stocks by growers and the influence of changes in fiber properties upon spinning quality, the North Carolina Station and textile schools cooperating with the Department of Agriculture found wide variations in spinning quality of cotton fiber grown from different seed stocks, indicating that precautions taken by growers to keep their planting seed pure are well worth while. Maintaining the purity of the seed stocks prevents a marked decrease in the length of staple and results in a fiber better suited to spinning purposes.

Securing a stand of cotton.—Poor stands annually cause a heavy loss to the cotton farmer. Experiments by the Georgia Station showed that applying fertilizer in contact with the seed and continued use of ammonium sulphate greatly decreased stands. Some varieties, especially Stoneville No. 2 and D. & P. L. 8, gave much better stands than others. In clay soils shallow planting was better than deep planting.

Crusts which are frequently produced under the alternate wetting and drying of the soil were found by the Alabama Station to seriously affect stands of cotton. Where the soil under the seed was sufficiently compacted, the plants could exert enough force to break the crusts, which then were not a serious handicap in getting a stand.

Fertilizing cotton.—The incorporation of limestone in complete fertilizers to the extent of neutralizing the acids developed in fertilizer mixtures has, in experiments reported by the Alabama Station, resulted in an increase of approximately 50 pounds of seed cotton per acre. (See also p. 19.)

Many field experiments have been made by the Georgia Station to determine the most economical uses of nitrogen fertilizers for cotton. The station has found, however, that the basal facts can be gotten

with more certainty by growing plants in small receptacles where conditions can be controlled and where the results can be measured accurately. Consequently, studies in the nutrition of the cotton plant have been made by the station in the greenhouses and the laboratories, using ammonium salts and nitrates as sources of nitrogen. This work has shown that ammonium sulphate as a source of nitrogen is potentially a very efficient fertilizer, but that the conditions for its use are much more exacting than for nitrates. Water-culture studies by the station have shown that the cotton plant has a very high boron requirement.

Winter cover crops for cotton.—Experiments, by the Louisiana Station, have shown that it is possible to increase the yield of cotton one-third to one-half bale per acre by use of cover crops grown at a cost of a dollar or so per acre for seed. Farmers of Louisiana spend as much as $2,250,000 a year for nitrogen fertilizer for cotton. The station believes that the greater part of this expense could be saved by growing winter cover crops for the improvement of soil. Furthermore, the yields of cotton following winter cover crops were larger than those obtained from use of nitrogen fertilizer, and there was also a substantial residual effect of the cover crop.

Shedding of cotton bolls.—The abnormal shedding of cotton squares and young bolls often reduces the returns from cotton fields from a profit to a loss. The Arizona Station has demonstrated that a very close correlation exists between shedding and the food-water relationship of the plants as indicated by the concentration of the expressed tissue fluids. Shedding was found to be high following periods of low concentrations of the sap of the plants. This results in a stimulation of vegetative growth to the detriment of the fruiting parts of the plants. Abnormal shedding also occurs following periods of excessively high concentrations of sap. Clean cultivation, crop rotation, terracing, and, in irrigation districts, proper irrigation, all influence the water-food relations within cotton plants and indirectly affect shedding.

Cotton wilt and rust.—High-potash fertilizing, according to the Arkansas Station, will control cotton wilt and rust. Use of potash and wilt-resistant varieties has greatly increased yields of seed cotton in the station's experiments. The station therefore recommends use of a suitable wilt-resistant variety and a fertilizer containing 6 percent nitrogen, 8 percent phosphorus, and 6 percent potassium.

Cotton flea hopper.—The Texas Station, in cooperation with the Department of Agriculture, has developed effective methods of controlling the flea hopper, which at times is very destructive to cotton. Dusting at weekly intervals with finely ground sulphur, 10 to 20 pounds per acre, depending on the size of the plant, has proved to be an effective means of controlling the pest under Texas conditions.

Mechanical harvesting of cotton.—A mechanical harvester, developed by the Texas Station, is simple enough to be easily converted into a horse-drawn machine. In trials, this machine has harvested 96 percent of the cotton in one operation, and with it one man can harvest 6 to 7 acres of cotton a day, thus greatly reducing the cost of this operation. The machine-harvested cotton when ginned proved to be equal in grade to cotton gathered by hand-snapping as commonly practiced in the western Cotton Belt.

One-variety cotton communities.—One-variety community cotton growing, started in 1931 by the Georgia Station cooperating with the Department of Agriculture, had spread to 35 or more communities in 1934, and the demand from farmers for such work had grown beyond the capacity of the station. Surveys of two communities showed that farmers estimated that the value of their crop had been increased $6 per acre by growing purebred Stoneville No. 2 cotton and that their premiums varied from $2.50 to $5 per bale.

Improving quality of cotton.—As a result of cotton-breeding experiments by the Arkansas Station, there has been a distinct improvement in the quality of cotton produced in the State. Since 1928 staple lengths of 1 to $1\frac{1}{32}$ inches, in terms of total production, have risen from 18 to 30 percent. The gain in longer staple has been at the expense of staple of seven-eighths inch and under. It is estimated that this improvement has increased appreciably the annual value of the Arkansas cotton crop, as measured by the price in central markets.

Fiber improvement, one of the most prominent features of the cotton-breeding work of the Arizona Station, has been greatly facilitated by improved technic made possible by a new type of sorter, designed and built by a member of the staff. As a result of the progress made, an improved strain of upland cotton is being increased in the Yuma cotton district to provide seed for the general grower. This strain of cotton is featured by increased uniformity in length and high percentage of the fiber.

The value of the cotton crop in Louisiana in 1934 is estimated to have been increased $2,500,000 as a result of practical application of information supplied by the Louisiana Station, especially regarding improved varieties of cotton. The breeding of better varieties over the State in cooperation with farmers and the growing and distribution of better seed has resulted within the last 6 years in a decrease in staples shorter than seven-eighths inch from 12.9 to 2.6 percent of the crop. It has resulted in a decrease of seven-eighths and twenty-nine thirty-seconds inch staple by 10.9 percent. There has been a corresponding increase in the better staples. Of the 5 leading varieties of cotton in the tests over the State last year, 3 of them were bred by the station.

Three strains of early-maturing cotton, especially adapted to different parts of the State and giving high yields and good quality of fiber in spite of bollweevil attack, have recently been developed by the Texas Station. These are Mebane 141 for west Texas, Startex 619 for central Texas, and Mebane 804–50 for south Texas. Finding that bollweevils are more readily poisoned on plants with hairy leaves and branches, the station is attempting to develop varieties having this characteristic in addition to other good qualities. The station is also attempting to develop strains of cotton that can be more easily harvested with machinery.

Economic advantages of improving cotton.—The economic advantages of improving the quality of cotton have been studied by the Oklahoma Station, and ways and means of securing such improvement have been pointed out, such as efforts to secure better grades and longer staple lengths, earlier maturity, and more prompt and better methods of harvesting.

From a study of prices paid farmers for cotton, the Tennessee Station, cooperating with the Department of Agriculture, considers the local-market premiums and discounts for the grade and staple length, paid in the usual market channels, to be considerably less than are justified by central-market prices. Better grading and prices were obtained through cooperative marketing.

CORN

Improved corn hybrids.—In cooperation with the Department of Agriculture, the Iowa Station has developed and distributed to seed growers four corn hybrids which seem especially adapted to different parts of the State. Minhybrid corn, a three-way cross produced by the Minnesota Station, appears to be well adapted to southern Minnesota where it has given increased yield over commonly grown varieties of approximately 20 percent. It excels in ability to withstand lodging and ripens uniformly.

Varieties of corn for silage.—After many years' comparative tests of different varieties of corn, the New York (Cornell) Station concludes that—

> the best type of corn for silage is one which utilizes the growing season to the best advantage in the production of dry matter, but which at the same time reaches, at least 3 years out of 5, a stage of maturity which may be loosely described as the dough stage.

Results of New Jersey Station experiments with silage corn indicate that while use of nitrogen fertilizers increases the total yield of corn, it does not increase its percentage content of protein. Hence dairymen cannot expect to reduce the need and cost of protein from other sources by use of heavy applications of fertilizers to increase protein in corn grown for silage.

Effect of stand on yield and variability of corn.—With regard to effect of stand on yield and variability of corn, the Nebraska Station found that in general—

> There may be considerable irregularity in the distribution of plants in a cornfield without the yield of grain per acre being materially affected. Such unevenness in stands, however, tends to increase the variability of plant development. Maximum uniformity among plants may be achieved through seed selection and planting practices that are conducive to uniformity of stand. Experience has indicated that stand irregularities materially greater than those herein considered, such as are sometimes caused by rodents, worms, birds, and soil washing, would undoubtedly increase the plant variability and lower the yield.

Fertilizers for corn.—Experiments by the South Carolina Station in a 3-year crop rotation of cotton, corn, and small grain indicated that nitrogen is often the only fertilizer material which produces a significant increase in the yield of corn, and that corn does not as a rule respond to potash fertilizers. However, in some of the poorly drained land of the Coastal Plain, potash deficiency has resulted in almost complete crop failure. The addition of the equivalent of 100 pounds per acre of potassium chloride has resulted in good crops of corn.

Hastening maturity of corn.—The North Dakota Station finds that the use of phosphatic fertilizers advances the maturity of corn materially and is profitable in a rotation of corn, wheat, and oats.

Insect pests and diseases of corn.—In experiments to determine the best time to turn under legumes and plant corn to avoid injury from the southern corn rootworm, the Alabama Station found that—

> The most serious injury occurred in corn planted following the turning of legumes March 15 and the least injury following the turning April 15. No serious injury occurred to any corn planted at Auburn April 30 or thereafter following the turning and disking of winter legumes on or before April 15.

An inbred chinch-bug-resistant strain of corn which appears to have possibilities of satisfactory yield and quality is reported by the Illinois Station.

Methods of controlling the European corn borer without adding greatly to the cost of corn growing are being developed by several experiment stations cooperating with the Department of Agriculture. For example, the breeding of strains of corn which show a marked resistance to corn borer attack has been a promising development of work of the Michigan Station cooperating with the Department of Agriculture. Crosses of native corn with Maize Amargo, a late-maturing borer-resistant corn from South America, have been obtained which encourage the hope that a strain resistant to the borer and of desirable agronomic qualities may ultimately be produced. As a result of extensive studies by the Illinois Station, cooperating with the Department of Agriculture, a corn hybrid (R4–Hy) has been developed which shows great promise with reference to borer resistance.

Assuming that it is probably impossible to eradicate the borer or entirely prevent its continued spread, the Indiana Station has undertaken to find effective adjustments to corn borer conditions. These involve certain modifications of rotations and farm practice now in use by Indiana farmers which the station believes will lessen damage from the borer without greatly increasing cost, including burning or turning under of stalks and trash, new adjustments of crop and livestock production, and use of improved machinery.

The bud worm or southern corn rootworm is a very destructive insect in the Southern States. As effective means of dealing with it, the Georgia Station recommends plowing and disking land several weeks before planting corn so that all vegetation will be killed and the worms starved, and planting corn thickly at several different dates. Drainage of bottom lands is also advised because the worms thrive in wet soils.

In attempts to develop strains of corn and sorghums resistant to grasshoppers (p. 21), the South Dakota Station found that flint corn is decidedly more resistant to grasshopper ravages than dent corn and that various kinds of sorghum are even more resistant than flint corn. Using this information it was possible to grow forage under recent conditions of drought and grasshopper infestation in South Dakota. It helped many farmers during the winter of 1933–34 to "rough through" livestock which would otherwise have been sacrificed.

White bud of corn, a chlorotic condition of the buds and new foliage of corn growing on certain types of soil that have been in cultivation for some time, the Florida Station found, could be corrected by application of zinc sulphate at the rate of 15 to 20 pounds per acre in the fertilizer used.

WHEAT

Varieties of wheat suited to Colorado conditions.—Varieties of wheat suited to varying conditions of high altitude, dry farming, and irrigation in Colorado have been developed by the Colorado Station, which has recently published practical directions for seed treatment, cultural methods, and storage of such wheats.

Sprouting of small grains in the shock.—In a study of dormancy in wheat and other small grains, with special reference to sprouting in the shock during wet seasons, the Colorado Station found a marked relationship of the length of the dormancy period and resistance to sprouting. For example, Kanota oats, which has an especially long dormancy period after harvest, showed a marked resistance to sprouting in the shock. Marquis wheat showed considerable dormancy and resistance to sprouting for 10 days after harvest.

Molding of wheat in storage.—The Kansas Station has shown that most damage from molding of wheat in storage occurs when the moisture content of the grain is 20 percent or more and the temperature exceeds 60° F.

Improved varieties of wheat.—Mammoth Red wheat has been found by the Maryland Station to be resistant to septoria glume blotch and suited to the low land in Maryland. It now occupies the major part of the acreage on the Eastern Shore and the lower limestone valleys of Washington and Frederick Counties.

Leapland, a selection of the Leap variety, has given, in experiments reported by the Maryland Station, an average yield of 3.6 bushels more than Leap and 4.5 bushels more than Mammoth Red. The results indicate that this variety can be profitably used on much of the wheat acreage of Maryland.

Thatcher wheat, a new hybrid developed by the Minnesota Station and the Department of Agriculture, which is awnless, stiff-strawed, high-yielding, and stem-rust-resistant and appears to be satisfactory in milling and baking qualities, was released to farmers in the spring of 1934 to the extent of 2,000 bushels.

Michigan Wonder, developed by pure-line selection, was introduced by the Missouri Station in 1919. At present it is the most productive variety in the State and is by far the most widely grown single variety. It is especially adapted to the more fertile, well-drained uplands.

A strain of Fulcaster for uplands of medium fertility, one of Poole suitable for flat, poorly drained prairie lands, and another of Harvest Queen adapted to rich, heavy bottom lands have been developed by the Missouri Station.

A new early wheat especially suited to Missouri conditions is now ready for release by the Missouri Station. This variety, as yet unnamed, matures at least 10 days ahead of any other variety now grown in Missouri. This early maturity will enable the Missouri farmer to get his wheat crop to market ahead of the seasonal glut, and is extremely favorable to intersown legumes. The wheat also misses the June drought or the last heavy rains, depending upon the season.

High-yielding varieties of wheat resistant to both loose and covered smut, which cause large losses in Pennsylvania in some years,

are about ready for distribution to growers by the Pennsylvania Station.

Albit, a new soft, white wheat produced by crossbreeding and selection at the Washington Station, cooperating with the Department of Agriculture, and distributed in small quantities to farmers in 1927, is being produced on a greater acreage than ever before. It was estimated that there would be a yield of more than 15,000,000 bushels of this wheat in 1934 in Washington and Idaho. Smut resistance, prolific yields, and qualities desired by the market are its chief advantages.

OATS

Improved varieties of oats.—Two new varieties of oats introduced by the Department of Agriculture, resistant to rust and giving exceptionally good yields, have recently been distributed by the Florida Station. One of these, known as Victoria, comes from South America, and the other, Bond, is a native of Australia. These varieties are the product of several years' efforts of the station to find an oat fully resistant to crown rust and yielding better in Florida than the Fulghum or Red Rustproof.

Three-fourths of the Missouri oats acreage, according to the Missouri Station, is now occupied by two varieties, Fulghum and Columbia, and these varieties, particularly Fulghum, are extensively grown in adjacent States. The Fulghum grown in Missouri is an improved strain of that variety developed and distributed by the station. Columbia is a new early variety developed by selective breeding by the station. Columbia is stated to have proved itself 25 to 30 percent more productive than the old late varieties previously grown in the State. Previous to the widespread use of these varieties, the oats crop of Missouri depended very largely on the season and was frequently a failure because of drought before maturity. With the Fulghum and Columbia varieties this hazard is greatly reduced.

Lenroc, a new high-yielding white oat, similar to Cornellian in all but color, has been developed and is now being multiplied for distribution by the New York (Cornell) Station, cooperating with the Department of Agriculture.

High-yielding varieties of oats resistant to smut are about ready for distribution to growers by the Pennsylvania Station.

BARLEY

An improved variety of winter barley.—From seed of ordinary Tennessee winter barley, the Missouri Station has developed and is distributing a strain showing superior winter resistance in Missouri and of value as a grain and pasture crop. This new variety is not only highly winter-resistant but also extremely early in maturing grain. It is thus valuable as a nurse crop for legumes, especially Korean lespedeza on thin soils, and escapes the effects of serious drought.

RICE

Improved varieties of rice.—In recent years four new varieties of rice have been released to growers by the Louisiana Station, cooperating with the Department of Agriculture. Two of these, Fortuna

and Rexoro, are being planted to a considerable extent and give good yields and improvement in quality over ordinary varieties. The premium now being paid for Rexoro as compared with Blue Rose is 50 cents a barrel; for Fortuna 35 cents a barrel.

Control of the rice weevil.—The Arkansas Station has shown that yields of rice may be increased over 17.8 percent by use of proper methods of drainage for control of the rice water weevil, the most important rice insect in Arkansas. Since the immature stages of the weevil are spent entirely under water among the rice roots, most of the larvae may be destroyed by drainage. The optimum time for drainage is when severe root pruning is beginning to be evident. In summer this is usually 3 to 4 weeks after first flooding and when most of the larvae are in the third instar. Delaying drainage as long as possible without injury to the rice plants favors increased yields. The drainage should be continued until the soil is entirely dried. Except during periods of extreme drought and high temperature, this period should not be less than 2 weeks.

Control of stem rot and seedling blight of rice.—Stem rot of rice is a widespread and often very destructive disease of this crop. The Arkansas Station, cooperating with the Department of Agriculture, has shown that it can be controlled to a considerable degree by early drainage, withholding standing water from the fields for a time prior to maturity. This method is being used successfully by rice growers. The station has also shown that seedling blight of rice may be reduced considerably by early planting and by getting the soil into a good condition of tilth before planting.

Nitrogen requirements of rice.—Lack of a sufficient supply of available nitrogen in the soil has been found to be one factor tending to limit the field yields of rice by the Arkansas, Texas, and California Stations. Application of ammonium sulphate has increased the yields of rice in Texas and California, and in Arkansas increased yields have been obtained by the growing of the crop after leguminous winter cover crops were plowed under.

POTATOES

Improved varieties of potatoes.—A number of new potato seedlings have been developed by the New York (Cornell) Station and the Department of Agriculture which are outstanding in uniformity, yield, appearance, and quality. It is thought that some of these new seedlings will undoubtedly displace older varieties.

Hardy potatoes.—A growing temperature averaging around 58° F. is more conducive to hardiness in potatoes than a mean temperature 10° higher, according to studies reported by the New Hampshire Station. Potatoes from northern-grown seed are therefore likely to have greater resistance to early frosts than those grown under milder conditions.

A potato rotation.—The Ohio Station reports good results with a 2-year rotation in which large silage corn is grown and plowed under 1 year, followed with rye as a winter cover crop, then potatoes in the second year. Moderate soil acidity (about pH 5.5) has been found to be desirable.

Fertilizers for potatoes.—Magnesium deficiency in potato soils, causing a chlorotic condition of potato foliage, particularly the early

growth, has been shown by the Maine Station to be a distinctly limiting factor in potato production in the Aroostook County potato-growing area, reducing the yield in some cases as much as 50 percent. The use of magnesium in potato fertilizers at the rate of 20 to 30 pounds of magnesium oxide per acre on fields showing a lack of magnesium gave increases in yield ranging from 19 to 56 barrels per acre. As a consequence fertilizer dealers are now offering potato fertilizers carrying a larger percentage of magnesium than those previously in common use.

Magnesium deficiency resulting under high tillage conditions has been shown by the Rhode Island Station to affect unfavorably the yield of potatoes. The deficiency effect is most pronounced on acid soils and where commercial fertilizers have been used in large amounts for a number of years. Rhode Island potato growers are being advised to use fertilizers containing magnesium and to use magnesium limestone to correct soil acidity.

Side placement of fertilizer in narrow bands about 2 inches on each side of the potato seed piece and on a level with or slightly below the seed piece has been found by a number of stations, including Maine, Michigan, New Jersey, Ohio, and Virginia Truck, to give better results in general than placement either over or under the seed piece.

Control of potato diseases.—Potato growers in Aroostook County, Maine, are closely following a spray service started in 1931 under the direction of the local farm bureau aided by the Maine Station. By following the spray-service advice in 1933, they saved the cost of the first two spray applications of the season, which would have given no benefits. The spray service also advised a late application which gave a noteworthy increase in yield by reducing flea-beetle injury late in the growing season.

A direct relation between soil acidity and prevalence of potato scab was observed in experiments reported by the New York (Cornell) Station. Potatoes on the most acid soils had the least scab. The ascending order of susceptibility of varieties was Russet, Rural, Cobbler, Green Mountain, and Up-to-Date for the varieties commonly grown in the State. There was generally less scab where potatoes followed sod than where they followed other cultivated crops.

Marketing potatoes.—The Maine Station has found that under normal conditions marketing a Fancy potato and a second unclassified grade gives higher returns than marketing U. S. No. 1 alone. With a crop of unusually low quality, however, there may be an actual loss if the two grades rather than U. S. No. 1 alone are marketed. This was true for potatoes picked and stored in the ordinary way. Picking and storing potatoes in the same containers eliminated considerable handling from the field to the grader and resulted in a much superior quality of potato. In general, the study showed the importance of improving the quality of the product in every practicable way, and particularly the necessity of being able to obtain a high percentage of Fancy if and when premiums are small and hard to get.

TOBACCO

Tobacco mosaic.—The Kentucky Station, among others, has shown that tobacco mosaic may originate from infected overwintered to-

bacco stalks. It may also be transmitted when plants are wormed and topped while leaves and hands are wet and contaminated with mosaic material. Mosaic infection of half-grown tobacco reduced the weight, length, and quality of burley tobacco markedly. When inoculated at topping time (some flowers blooming) weight was not affected, but there was a definite shift in grades, a larger proportion of the mosaic tobacco grading lugs, and less grading bright leaf than with the healthy tobacco.

Plowing under of diseased stalks and roots in the spring, refraining from the use of chewing or smoking tobacco while handling young plants, greater care in topping and the use of implements, and roguing out diseased plants are recommended by the North Carolina Station as means of controlling mosaic. Resetting in place of diseased plants is not advised.

Tobacco hornworm.—Barium fluosilicate has been found by the Tennessee Station to be effective in the control of the tobacco hornworm and to leave much less residue on tobacco leaves than either calcium or lead arsenate.

SUGARCANE

New varieties of sugarcane.—Since 1926 the Louisiana Station, cooperating with the Department of Agriculture, has released seven new varieties of sugarcane to the grower. In 1932 the production of sugar in Louisiana was 222,760 short tons and the yield of cane per acre was 15.5 tons as compared with 47,000 short tons and 6.8 tons, respectively, in 1926. The varieties released are resistant to diseases which caused the low yield in 1926. A new variety soon to be released has the advantage of maturing very early, thus increasing the length of the milling season and reducing the risk of freezing in the field.

Control of sugarcane borer.—Parasites for the control of the sugarcane borer have been distributed by the Louisiana Station. A considerable increase in yields has been obtained in fields colonized with parasites as compared with noncolonized fields. The station has also found borer-resistant strains giving promise of considerably increasing the yield over the less resistant kinds commonly grown.

SORGHUMS AND MILLETS

Sorghum a drought-enduring crop.—The South Dakota Station has shown that sorghums, including Amber sorgo and Sudan grass, are valuable drought-resistant crops. In the station's experiments they produced as much forage, under drought conditions, when seeded in single rows 36 inches apart or double rows 42 inches apart as when seeded in solid drill rows only 7 inches apart, as is done with small grains, thus making possible a considerable saving of seed.

Improved varieties of sorghum.—Improved varieties of sorghums suited to Kansas and adjacent territory having similar conditions have been developed by the Kansas Station.

Varieties of grain and forage sorghums suited to widely different conditions in Texas and elsewhere have resulted from long-continued investigations by the Texas Station. Among the more promising varieties are Chiltex, Premo, Darso, and Schrock, resulting from crosses, as well as Sumac, Honey, and Sourless. The largest yields

and best quality of forage from sorghums were produced by close spacing.

White proso, brought from Siberia in 1913 for large size and white color has been improved by the South Dakota Station to serve as a table cereal as well as grain feed for livestock. It appears to be well suited to western dry uplands.

SOYBEANS

Soybeans for seed and hay.—The Iowa soybean acreage, exclusive of that interplanted with corn, expanded from 471 acres in 1919 to 192,000 acres in 1933, according to figures reported by the Iowa Station. Thirty-five percent of the crop is harvested as seed while 65 percent is cut for hay. The percentage harvested for seed has been declining. The station finds the crop particularly adapted to southeastern Iowa and to the dairy section, and considers it an ideal emergency crop (see below). It competes with other crops most successfully on acid soil low in nitrogen and organic matter. The station recommends the following general-purpose varieties for both seed and hay: Manchu, Illini, Dunfield, Mukden, and Black Eyebrow. Detailed directions concerning culture of the crop have been published by the station.

Soybeans as an emergency crop.—On the basis of investigations carried on continuously since 1887, the Massachusetts Station has demonstrated the value of the soybean in times of shortage of forage due to unfavorable climatic or soil conditions. Generally the forage-producing capacity is in inverse ratio to the seed-producing capacity of the varieties tested. Seed production has varied widely according to the season. The highest yielding varieties tested, in cooperation with the Department of Agriculture, were: Dunfield 3.02 tons of cured hay, Habaro 2.75 tons, Medium Green 2.74 tons, Harbinsoy 2.7 tons, and Virginia 2.67 tons. The fine stems of Dunfield and Habaro make them preferable for hay. The station believes that the future of the soybean in Massachusetts lies in its capacity to produce high-protein forage rather than seed. As noted above, the Iowa Station considers the soybean an ideal emergency crop. Its large use in the Middle West to replace other crops destroyed by the recent drought is evidence of general acceptance of this view.

Improved varieties of soybeans.—The Cayuga soybean, developed by the New York (Cornell) Station from an introduction of the Department of Agriculture, has been shown to be early enough to ripen in New York and thus capable of producing a valuable home-grown feed, suited especially to meet the increasing demand of dairymen for a home-grown high-protein feed. It has been grown successfully at Ithaca every year for the past 6 years with an average yield per acre in cultivated rows of more than 25 bushels, and for the past 3 years in drill plats with an average yield of 38 bushels.

Scioto, a new variety of soybeans which the Ohio Station has tested in three widely separated parts of the State for several years has exceeded its nearest competitor in yield of seed per acre by 16 percent when compared with such standard varieties as Manchu, Illini, and Dunfield.

Soybeans for table use.—Work of the Mississippi Station with vegetable soybeans, carried on in cooperation with the Department of

Agriculture, has created much interest, particularly among large planters who have to supply food for numerous tenants. It is understood that a great many planters expect to utilize the vegetable soybean. Soybeans for forage and grain also have been popularized by the results of station work, and a large acreage is being planted in the State. Progress in finding more palatable varieties and strains of soybeans for table use than those commonly recommended was reported by the Tennessee Station. (See also p. 80.)

ALFALFA

Station work with alfalfa is extensive and varied. Methods of growing and using the crop are constantly being improved as a result of such work.

Alfalfa in Alabama.—The Alabama Station has shown that alfalfa may be economically produced in many parts of the State. On the red lands of the Tennessee Valley, large yields of alfalfa are obtained when substantial amounts of phosphate and lime are applied. On certain Black Belt soils, alfalfa thrives when only phosphate is supplied. These experiments indicate that much of the land in the State can be used for alfalfa production if proper fertilizers and methods of culture are used.

Hardy alfalfas.—Hardy or variegated alfalfas, particularly Grimm and Ladak, have been found by the Idaho Station to be best suited for seed production in Idaho, whereas seed from the southwestern United States and California has not been found to be adapted to the State.

Hardy variegated varieties of alfalfa gave consistently better yields than the average common varieties, in experiments by the Pennsylvania Station. Canada Variegated, Grimm, Ladak, and Cossack yielded best of the hardy variegated varieties tested. Of varieties commonly grown in other States, those of Utah, the Dakotas, and Kansas have been most consistently satisfactory in Pennsylvania. The tests have demonstrated the necessity of giving particular attention to the source of the seed to be used.

Wilt-resistant alfalfa.—Choice of alfalfa varieties for wilt-infected soils in Iowa has been found by the Iowa Station to lie between Cossack, Grimm, and Dakota and Montana common for short rotations and Turkistan, Hardistan, and Ladak for long rotations.

Alfalfa for seed production.—The Arizona Station brought out during the past year and is making available to growers a highly uniform strain of alfalfa for growth in the alfalfa-seed districts of the State. This strain has been developed by the pure-line method of breeding, and demonstrates the heritability of the main economic characters of the plant, namely, leafiness, uprightness of plant, and seed-setting.

Time of cutting alfalfa.—The fall growing season has been shown by the Kansas Station to be the critical period in the development of alfalfa with respect to permanency of stand and yield of hay. The station found that alfalfa which was not cut in late fall gave a decided increase in yield of hay at the first cutting the following spring, as compared with that cut in late fall. The station finds that alfalfa may safely be cut at the early-bloom stages during the spring

and summer months provided the last cutting is made early enough to allow for a fall growing period of about a month.

It has usually been possible to obtain three cuttings of alfalfa at the New York (Cornell) Station. The omission of the third cutting may increase the longevity of the stand by allowing the accumulation of greater food reserves to withstand such conditions as prevailed during the excessively cold winter of 1933–34. The extreme cold caused a decidedly greater mortality among plants cut three times annually than on those cut less frequently.

To lessen loss from leaf hopper injury the Kentucky Station recommends cutting the first crop of alfalfa in the nearly full-bloom stage, June 10–15, and cutting the second crop during the last week of July.

Curing and baling alfalfa hay.—In experiments reported by the Colorado Station, crushed hay required only 6 hours in bright sunshine to attain a moisture content of 20 percent, whereas from 3 to 4 days were required for this purpose by the common methods of curing.

Use of a crushing attachment to the mower devised by the Mississippi Station and windrowing greatly hastened the drying of alfalfa hay in experiments reported by the station. Double windrowing 2 hours after the hay was cut resulted in better color and larger percentages of leaves as well as more rapid drying of the hay.

A pick-up hay baler that bales alfalfa hay from the windrow has been devised by the Iowa Station. With skillful operation it showed an average capacity of 3 tons of hay per hour and a labor requirement of 1.35 man-hours per ton. The estimated cost of baling at the rate of 2.75 tons per hour was $1.42 per ton. An average of 4.5 horsepower from the take-off of the tractor was required to operate the baler.

Artificially dried alfalfa hay.—In experiments reported by the New Jersey Station, cows were fed solely on dehydrated alfalfa hay and silage for 3 months with very satisfactory results. The dehydrated hay was prepared and delivered into bins at a cost of $8.65 per dry ton.

LESPEDEZA

Lespedeza, especially the featured perennial type (*Lespedeza sericea*), has recently been studied by many experiment stations, cooperating with the Department of Agriculture, to determine its value as a pasture, forage, soil-improving, and protective crop against erosion (p. 16), particularly on lands withdrawn from cotton, corn, and other cultivated crops. The Georgia Station finds that the perennial lespedeza has considerable promise for hay and possibly for grazing and soil improvement in Georgia. The Missouri Station finds that probably the best use of the perennial lespedeza will be as a hay crop on land of medium to somewhat less than medium fertility, and on such land it may well take the place of alfalfa, sweetclover, or red clover, which cannot be grown in Missouri without expensive soil treatments. The station states, however, that it "cannot compete as a hay crop with alfalfa or red clover on land naturally capable of producing these legumes successfully", but that under Missouri conditions it "may be expected to produce two crops of hay in a season, or one crop of hay and one crop of seed, or one

crop of hay followed by summer pasture." Cut before the bloom stage and properly cured it produces an excellent quality of hay.

The Ohio Station finds the annual lespedezas as a group apparently somewhat better adapted to acid and thin soils than the common clovers. In other respects they have not shown any superiority over the clovers under Ohio conditions.

CROTALARIA

Species of crotalaria which seem to be superior to kinds previously grown in the South for use as a forage plant have been introduced by the Florida Station, cooperating with the Department of Agriculture. One of these, *Crotalaria intermedia*, adapted to high, sandy soils, has proved to be satisfactory for pasturage, hay, and silage.

FLAX AND FLAX SUBSTITUTES

Varieties of flax have been developed by the California Station, cooperating with the Department of Agriculture, from introductions from India and Africa, which yield from 25 to 30 bushels of flaxseed per acre in the Imperial Valley. As much as 11,500 acres of flax was planted in the Imperial Valley in 1933. It is estimated that 75,000 acres was planted in 1934. Growing this crop for oil production in California appears to be especially timely because it does not interfere seriously with the production of other crops, and the yields under good management are such that it will probably be profitable not only in Imperial Valley but elsewhere. It appears to be destined to become one of the staple crops of the State.

The production of flaxseed in Kansas is reported to be 250,000 bushels annually. The Kansas Station finds that flax is as profitable as wheat and more profitable than oats in southeastern Kansas. It is stated that the crop is not hard on the land. The straw is high in feeding value and its inclusion in small-grain farming systems makes for more efficient labor distribution. Information regarding methods of culture have been published by the station.

Flax grown for seed, in experiments reported by the New Jersey Station, yielded 13 percent greater cash returns than the highest yielding spring barley variety, 23 percent more than the best oats, and 67 percent more than the best spring wheat variety. Since the quality of the New Jersey product is excellent, the crop may fill the same place in crop rotations as the spring grains. It is stated that seed may easily be disposed of to flaxseed crushing mills within the State. Detailed directions for growing flax under New Jersey conditions have been published by the station.

Safflower, a suggested drought-enduring substitute for flax, has been tested with interesting results by the Montana Station, cooperating with the Department of Agriculture. It is stated that safflower germinates and grows naturally in soil too dry for the germination of flax. Under the most extreme drought conditions of the past summer the plant thrived and developed a good crop. Safflower is useful for oil production but not for fiber.

TUNG OIL PRODUCTION

The high value of Chinese tung oil for the manufacture of paints and varnishes has stimulated considerable interest in the growing of

tung-oil trees in the lower South. Through a cooperative arrangement with other agencies and growers, the Georgia Station instituted a program calculated to assist in the development of the tung-oil industry in that State. The oil content of nuts from selected trees compared favorably with that of nuts grown elsewhere.

Bronzing of the foliage of tung trees has become a serious trouble to Florida growers. Approximately 5,000 acres of commercial tung groves has been treated with sulphate zinc, in amounts varying from 0.25 to 0.5 pound per tree, as recommended by the Florida Station, to control the trouble. It is now apparent that bronzing can be successfully controlled, whereas previously the disease was usually fatal to the trees.

Horticultural Crops

In recent horticultural investigations the stations have been placing particular emphasis on such economic questions as the production and marketing of horticultural products of superior quality at minimum cost, control of new pests, and elimination of harmful spray residues.

FRUITS

New fruits.—Breeding for improved varieties and strains of fruits continued to be a major activity of a number of experiment stations. The need for improved fruits was strikingly illustrated in the failure of the Baldwin apple to withstand the severe winter conditions which have recently prevailed in areas where this variety has been commonly grown. This variety, which possesses many desirable qualities, is apparently lacking in real hardiness.

The Sharon apple, a McIntosh-Longfield cross, introduced by the Iowa Station, is stated to be a midseason bloomer, producing medium-size fruit of somewhat the color of Wealthy, the taste of the Grimes Golden, and attractive quality. It appears to have a certain degree of cold resistance.

The Babcock peach, developed by the California Station, has proved to be resistant to the delayed foliation disorder, which interferes with the growing of the standard varieties in southern latitudes. With Peento or South China blood in its parentage, this new variety set a good crop at Riverside in 1934 when many others failed.

Several of the peaches originated by the New Jersey Station have continued to do well under widespread trials. The Oriole has proved to be early-maturing, vigorous, and hardy, and capable of enduring short shipments. The Cumberland has shown resistance to low temperatures, and Sunbeam has been found to retain its color after peeling and slicing.

The Parker pear, developed by the Minnesota Station from seed obtained from Manchuria, appears to be decidedly winter-hardy and of good commercial value for that State.

The new grapes, Golden Muscat, Seneca, Stout Seedless, and Urbana, bred by the New York State Station, have been found to combine the fine quality of their vinifera (European) parents with the sturdiness of the American species.

Camden, Cato, and Clermont strawberries originated by the New York State Station have been grown with success by many different commercial producers.

Winter injury of fruit.—The excessive cold of the winter of 1933–34, with lowest temperatures in half a century or more, caused great injury to fruit and ornamental plants over the northeastern United States. For example, the commissioner of agriculture for Maine reported that one-third of the apple trees in 879 Maine orchards were killed or critically injured. Much the same situation obtained in New York State. As a result of its investigations on pruning, soil treatment, and fertilizing, the New York (Cornell) Station was able to aid orchardists materially in restoring fruit trees seriously injured by the unprecedented cold, which in some fruit sections of New York reached a minimum of 35°–40° F. below zero. The station showed that while low temperature was undoubtedly the decisive factor in the injury, the condition of the trees as determined by the amount of fruit borne in 1933 and damage caused by insects and diseases were also important factors. Injury was also found to vary in different parts of the orchard, depending on the topography.

A survey of winter injury from the standpoint of species and variety susceptibility by the New York State Station showed that old standard varieties such as Baldwin and Rhode Island Greening were so generally and severely injured as to raise the question whether these varieties should be used in replanting. The McIntosh group of apples was found highly resistant to low temperatures. Grapes were injured largely in proportion to their content of vinifera parentage. European plums showed greater hardiness than did the Japanese group. The station suggests that the freeze was perhaps not without its benefits in impressing upon plant breeders the importance of giving more attention to winter hardiness.

In view of possible increased damage to fruit trees by insect pests and diseases following winter injury, the New York State Station has made the following practical recommendations:

> Remove dead and severely injured trees from the orchard; cut out dead wood in less severely injured trees at the first opportunity; protect large cut surfaces with some tree paint; preserve young trees and those that give the greatest promise of recuperation, eliminating border-line trees that are on the decline; in the case of grapes, leave the dead trunk as a protection for the young shoots and retain all shoots in order to maintain the vigor and strength of the root system; and finally, cut back berry wood that is winter-injured as too much wood may cause a serious set-back in hot, dry weather.

Lack of mulch or extremely late mulching was found by the Wisconsin Station to result in winter injury to strawberry roots. The trouble known as black root, the station finds, may be largely avoided by early application of mulch.

Effect of excessive soil temperatures.—The Arizona Station reports that soil temperatures sometimes become so high on the Yuma Mesa as seriously to retard the growth of young grapefruit trees. The station found that mulching with Hubam clover greatly mitigated the harmful effects, trees mulched with the clover making twice as much trunk growth as unmulched trees.

Pollination and set of fruit.—Pollination and set of fruit continued to be an important subject of investigation by a number of experiment stations. Investigations relating to pollination and set of fruit in apples, cherries, and other fruits were reported during the year.

Baldwin, Jonathan, Rome Beauty, and Gallia Beauty are recommended by the Ohio Station as apple varieties showing the highest degree of self-fruitfulness, but the station points out that even these

varieties set fruit better when cross-pollinated. McIntosh has been shown by the New Hampshire Station to be largely self-unfruitful. Several compatible varieties to be planted with it are suggested by the station, including Wealthy, Red Astrachan, Delicious, Fameuse, and others.

Weather conditions during the blooming period, the Michigan Station finds, may reduce the set of fruit in cherries by interfering with pollination by bees during rainy weather and by preventing the normal shedding of pollen during periods of high humidity. Low temperatures also interfere with pollination by bees. Excessive shading, as well as severe defoliation, was found to interfere with setting of fruit. The station found that cherry trees withstand a considerable reduction in light intensity without materially reducing the set of fruit. Under normal conditions the reduction in light intensity in the center of the tree is not a direct cause of reduction in set.

A study of cherry pollination by the Utah Station showed that of the varieties commonly grown in Utah, Windsor, Black Tartarian, Schmidt, and Yellow Spanish are satisfactory pollinizers with sufficient economic value to justify their use under certain conditions in Utah.

Artificial ripening and coloring of apples.—The West Virginia Station has found that ethylene, ethylene chlorohydrin, and ultraviolet irradiation treatments of stored Rome Beauty, Stayman Winesap, and Ben Davis varieties did not materially affect the chemical composition of the fruit or the acidity of the expressed juices as compared with similarly stored untreated fruits. Ethylene treatment hastened the color change from green to yellow and likewise accelerated the softening of the apple tissues.

Marketing early apples.—From a study of producers' practices and consumers' demands bearing on effective marketing of early apples in Delaware, the Delaware Station concludes that early apples should not be picked too immature because this may discourage the consumer from purchasing more apples. They should be handled very carefully because they bruise easily and the bruises are very conspicuous. Early apples should be thinned to get adequate sized fruit, which commands a higher market price. The station suggests that Delaware growers who expect to plant early apples should consider the Starr, which is popular among wholesalers and commands a premium because of its early maturity.

Blueberry culture.—The blueberry, one of the most prized of native fruits, has been domesticated and improved through the efforts of the Department of Agriculture, the experiment stations, and other agencies. The Michigan, Maine, and New Jersey Stations among others, have given special attention to the improvement of the quality and culture of the blueberry. The Michigan Station finds that—

> The blueberry plant is very exacting with regard to its soil requirements. The soil must be very acid, well supplied with moisture, and of the proper texture. Sand or muck soil or a mixture of the two are preferable. Clay soils are unsatisfactory. If the soil is not sufficiently acid, plants make very poor growth and many of them die. A water table from 14 to 22 inches below the soil surface has been found most satisfactory. Insufficient moisture in the soil will result in lack of production and, in severe cases, in the death of the plants. Blueberry plants also can be stunted in growth or killed by excess water during the growing season.

The highbush varieties commonly grown in Michigan are usually winter-hardy but sometimes suffer from excess of moisture in the soil and very high temperature. The Michigan Station has had good success in propagating both softwood and hardwood cuttings, using German peat as a propagating medium. The principal varieties now grown in Michigan are: Cabot, Adams, Pioneer, Rubel, Rancocas, Harding, Concord, and Jersey. The station is developing promising seedling varieties.

Clearing land and keeping it clear has been found to be very expensive. Superphosphate is the only fertilizer that has shown positive benefit in the Michigan experiments. Only moderate pruning is advised.

The blueberry maggot is the most serious insect pest and crown gall the most serious disease of blueberries in Michigan.

Effect of mineral deficiency or excess on citrus fruits.—The Arizona Station reports a decline of citrus trees, due apparently to inadequate available iron in the soil. Iron salts injected into the trunks, distributed in the root zone, or sprayed on the foliage brought about a marked improvement in the condition of the trees.

A chlorotic condition of citrus leaves commonly known in Florida as "frenching" was found by the Florida Station to respond very satisfactorily to sprays containing zinc sulphate combined with hydrated lime or lime-sulphur solution. Cases of long standing gave good and prompt response to the treatment. Small applications of manganese sulphate were found by the station to increase the growth of citrus trees and improve the quality of the fruit.

Citrus packing-house costs.—In further study of the cost of handling citrus fruit from the tree to the car, the Florida Station found the volume of fruit handled by the individual packing house to be one of the outstanding factors affecting costs. For 14 packing houses with volumes of more than 200,000 boxes each the total handling cost per box of fruit during the 1931–32 season was 67.2 cents as compared with $1.14 in 10 houses with volumes of 25,000 boxes or less. Labor, management, and fixed investment charges were influenced most by volume of fruit handled, and it is advised that on the average a volume of from 60,000 to 70,000 boxes of fruit is necessary for economical operation.

Maturation of dates in cold storage.—The Arizona Station has found cold-storage maturation of fresh dates to be a feasible method of handling fruit to be held for winter and early spring marketing. The most satisfactory procedure is to harvest fully translucent fruit, pasteurize it, and place it immediately in storage. This fruit maintains a higher grade after 4 months' cold storage than does fruit processed and dehydrated before storing. The cold-storage maturation method eliminates the cost of heat maturation and dehydrating.

Control of fruit insect pests and diseases.—Despite advances in knowledge of spray materials and improvements in spraying methods and machinery, control of insect pests and diseases remains a difficult problem for the fruit grower. Substantial progress was made during the year in improving control methods, and in developing varieties resistant to diseases.

Of nematode-resistant forms of peach and nectarine seedlings developed by the California Station, cooperating with the Department

of Agriculture, from Asiatic varieties, one, designated "Shalil" is proving to be a desirable stock for commercial varieties.

Losses from crown gall of apples, the New York State Station finds, may be greatly reduced by budding nursery stock instead of grafting.

Effective control of apple scab on McIntosh apples was secured with lime-sulphur mixture by the Maine Station. The New York State Station has found that lime sulphur both eradicates scab and prevents infection on apples.

Results of further experiments in control of fire blight, by the Arkansas Station, confirmed previous conclusions that this disease as it occurs on apples can be reduced with a 1 : 3 : 50 bordeaux mixture sprayed on the trees in full bloom.

The oriental peach moth, a widespread and destructive enemy of the peach, has to a considerable extent been successfully controlled by the New York State Station with the aid of parasites. Parasite control of the moth in apple orchards has been found by the Connecticut (State) Station to be rather slow and to a large extent dependent on favorable weather and other environmental conditions. Supplementing parasite control with careful clean-up measures in the packing house is recommended by the Maryland Station as a means of controlling the insect.

New spray materials.—Considerable advance was made in 1934 in developing new spray materials and combinations, particularly those that may reduce the spray-residue hazard.

A dust consisting of 1 part of calcium arsenate and 19 parts of lime, applied at the time of flower-bud appearance, was found by the Michigan Station to be effective in controlling the raspberry beetle without hazard of harmful residues. The station has used derris or pyrethrum sprays successfully in control of the raspberry sawfly, thus avoiding objectionable residues.

Tar-distillate emulsions have been successfully used by the New York State and Virginia Stations in control of certain apple aphids.

More than 100,000 gallons of fish oil is reported to have been used by apple growers in the Wenatchee district of Washington in the 1934 season. According to the Washington Station, the addition of fish oil to the usual lead arsenate sprays increases their effectiveness. Pacific coast herring and dogfish oil were found to be economic sources of oil.

Removal of spray residue from fruit.—With Federal tolerances for arsenic, lead, and fluorine established, spray-residue reduction or removal has become a major subject of investigation by the Department of Agriculture and the experiment stations in the important fruit-growing districts. Relief has been sought along three main lines—modification of the spray program to reduce the amount of residue, removal of the residue, and substitution of other effective spray materials for those containing arsenic, lead, and other substances highly toxic to human beings.

A primary necessity in dealing with the spray-residue problem is rapid and reliable methods of determining lead and other toxic substances in the residues. A colorimetric method of determining small amounts of lead has been proposed by the Michigan Station. A simplified method of determining lead which appears to be applicable

for use in the field by Federal and State food inspectors has been proposed by the Pennsylvania Station. Removal of the residue has received much attention.

An inexpensive but effective home-made fruit washer for apples and pears has been designed, constructed, and demonstrated by the New York (Cornell) Station. The acid washing process has been found effective by the Virginia Station in removing arsenic and lead from apples sprayed with arsenate of lead. Further tests by the Washington Station of fruit-washing solutions has led to the adoption of sodium silicate as a wash and the use of soap in the silicate solution to increase the effectiveness of the cleansing process.

Fruit products.—Utilization of surplus and cull fruits for preparation of products which may give new and remunerative means of disposing of such fruit is being investigated by a number of experiment stations, notably the California and New York State Stations. A few examples of investigations of this kind recently reported follow:

Methods of preparing bottled apricot juice have been developed by the California Station as a means of utilizing small apricots in the manufacture of a product suitable for many purposes and of commercial possibilities.

The color, flavor, and other qualities of apple juice, the New York State Station finds, can be preserved by bottling in green-glass bottles or in clear-glass bottles wrapped in transparent green coverings.

A method of preparing an apple-juice concentrate, retaining the characteristic apple aroma and flavor, and suitable for use in preparing beverages and for other purposes, has been proposed by the New York State Station. A commercial fruit concentrator equipped with a device for returning to the concentrated juice the volatile esters which are responsible for its aroma and flavor is used for concentrating the juice. Since carbonated beverages are usually made by adding carbonated water to a small amount of sirup rather than to a more dilute preparation, it is thought that the apple concentrate will appeal to bottlers as well as those who prepare carbonated beverages. It is stated that a beverage strikingly similar to fresh apple juice can be made by adding water to the concentrate.

See also p. 80.

Darkening of cut fruit.—Darkening of certain fruits on cutting and exposure to air is a disturbing problem in commercial as well as home use of fruits.

The cause of darkening of apricots in the drying process has been determined by the California Station and possible ways of avoiding it have been suggested.

The darkening of peaches on peeling and slicing and exposure to the air has been found by the New York State Station to be due to a tanninlike substance which turns brown when the fruit is exposed to the air. Such darkening has been observed especially with yellow peaches. However, Sunbeam, a yellow peach originated by the New Jersey Station, is apparently not subject to such discoloration. This knowledge of the cause and detection of discoloration has furnished a basis for a simple test to determine the extent of browning that may occur in different varieties of peaches. The test consists

of adding 1 cc of a 1-percent guaiacol solution or 1-percent hydrogen peroxide solution or both to 10 cc of a clarified mixture of equal parts of cooled juice and water and observing the degree of deepening of the color. Such a test is of value to the plant breeder as well as from the commercial and the household standpoints.

VEGETABLES AND MELONS

Improvement of varieties, methods of culture, management, and marketing of vegetable and similar products are leading lines of work by the experiment stations which have resulted particularly in products of better quality, more resistant to diseases and insect pests, and more acceptable to consumers and therefore bringing better returns to the producer.

Improved varieties.—Distinct advances in securing strains of vegetables resistant to disease were recorded during the year.

Two mosaic-resistant strains of green Refugee beans, considered better than the standard Refugee for canning purposes, have recently been developed by the Idaho Station cooperating with the Wisconsin Station. The new strains mature earlier and yield as well as if not better than the commercial varieties. Sufficient seed is produced to permit distribution of small lots to interested seed producers.

Cabbage yellows, a widespread and destructive disease, has been the subject of much investigation by the Department of Agriculture and a number of experiment stations, including especially those of Wisconsin, Iowa, and others. As a result, at least eight varieties of good commercial value suited to different conditions of culture are now in common use.

A strain of Golden Self Blanching celery extremely resistant to a fusarium disease known as yellows has been developed by the Michigan Station. The new strain, introduced under the name of Michigan Golden, has found favor with commercial growers, and seed in considerable quantity is being produced for growers.

Wisconsin Perfection, a new wilt-resistant strain of canning pea developed by the Wisconsin Station, has been tested by commercial growers with highly satisfactory results. The new pea, with the earlier maturing wilt-resistant variety, Wisconsin Early Sweet, previously introduced by the station, assure canners a steady supply of good-quality peas throughout the season and will undoubtedly lessen losses from pea wilt.

Uniform strains of Long Red Cayenne and Tabasco peppers obtained in selective breeding by the Louisiana Station have proved about twice as productive as the common commercial varieties. A considerable quantity of seed has been distributed to commercial growers and it is confidently expected that the new peppers will greatly increase the income of producers.

Louisiana Copenhagen, a strain of Copenhagen Market cabbage, developed by the Louisiana Station, has proved very acceptable to growers and consumers because of its uniformity, compactness, and high quality.

Hopeland, a new sweet corn produced by the Maryland Station from a cross between Stowell Evergreen and Johnson County field corn, was further developed with reference to uniformity, type, and

improved quality. This new corn appears to have relatively high resistance to corn ear worm injury.

Tests by commercial growers of the new Texas Station sweet corns, Surcropper Sugar and Honey June, have brought out the fact that these varieties are very well adapted to the rather exacting conditions of the Southwest.

Several new strains of Porto Rico sweetpotatoes of higher yielding capacity and greater uniformity in shape and quality than varieties commonly grown have been developed by the Louisiana Station.

A new variety of tomato, Century, comparing very favorably with the well-known Marglobe as a canning and market-garden variety and especially adapted to the hot, dry summers of the Central States, has been developed by the Illinois Station.

Strains of cantaloups and Honey Dew-type melons resistant to powdery mildew are reported by the California Station cooperating with the Department of Agriculture. The station predicts that in a few years resistant varieties will be available for the entire melon crop of the State.

Certain strains of watermelons of uniform type, good quality, and highly resistant to wilt have been secured as the result of breeding and selection by the Florida Station. These are ready for commercial introduction as soon as sufficient seed can be produced.

The fruit and melon belt is constantly being moved northward by the development of new varieties. A northern sweet watermelon which is unusually early in maturing, ripening 2 weeks ahead of ordinary varieties, has been developed and introduced by the Minnesota Station. It is of high quality and is believed to be of particular value both for home use and for commercial purposes in more northerly regions.

Fertilizer needs of vegetables.—That vegetables growing on certain types of soil have a predominant need for phosphorus was indicated in extended fertilizer experiments carried on by the New York State Station. When the phophorus deficiency was remedied nitrogen became a limiting factor, and when both phosphorus and nitrogen were supplied adequately the application of potash appeared worth while. A fertilizer containing 4 percent of nitrogen, 16 percent of phosphorus, and 4 percent of potassium, or possibly one containing 4, 12, and 4 percent, respectively, of these ingredients is suggested where moderate applications of fertilizer are to be made.

Compounds of copper, boron, iodine, bromine, and arsenic used at the rate of approximately 0.15 g of the elements per plant were found by the Kentucky Station to increase the growth of tomatoes, lettuce, cabbage, turnips, rape, beans, and carrots. In case of cabbage nutritive value was apparently increased by the treatment.

Beets made optimum growth when liberally supplied with available nitrogen (nitrate) during the first two-thirds of their growth period, at the Rhode Island Station. On the contrary celery grew best with low nitrates at setting time and larger applications during the final two-thirds of the growth period.

Electrically heated hotbeds.—Excellent results in the propagation of woody plants have been obtained with an electrically heated hotbed devised by the New York (Cornell) Station. When used over a period of months, the electrically heated hotbed showed a decided

saving in cost of operation over the customary manure hotbed which must be renewed at frequent intervals. Since the same rooting medium is used repeatedly in the electrically heated hotbed, chemical treatments are necessary for control of damping-off fungi.

Vegetable-seed production.—Substantial progress was reported by the New Mexico Station in the study of vegetable-seed production, with particularly encouraging results with onions, beets, carrots, parsnips, and head lettuce. The possibility of developing an onion-seed industry in Texas has been demonstrated by the Texas Station. Seed of excellent quality produced in an experimental way gave favorable results when tested in certain important onion-producing areas.

Cutting asparagus.—The Illinois Station has found that heavy cutting materially reduces quality and yield of asparagus, the annual crop of which in Illinois is stated to be worth $450,000. Cutting the asparagus bed during the first year after setting was not profitable, in experiments reported by the station. Light cutting the second year and medium cutting the third year gave the highest yield and quality. Cutting for 4 weeks the second year after setting reduced yields. If the plantation has made very poor growth during the first and second years after setting, it may be advisable to delay cutting until the third year or, at the most, cut very lightly the second year.

Production of healthy tomato seedlings.—Extensive work by the Georgia Station has resulted in action by the State Board of Entomology requiring tomato-plant growers to use good seed, treat the seed with disinfectants before planting, and to spray the plants before pulling for shipment. The station is cooperating with the board in working out methods of tomato-plant certification and in testing the value of the seed certification in other States.

Pruning and training tomatoes.—From an extensive study of the subject of pruning and training tomatoes from the commercial grower's standpoint, the New York (Cornell) Station concludes that these practices are not likely to be profitable in New York except for the production of unusually high-priced fruit.

Improving tomatoes for manufacture of juice.—The New Jersey Station reports progress in determining the factors affecting the quality of tomato juice. It has been found, among other things, that changes in the environmental factors of temperature, moisture, and sunlight within the growing season perceptibly influence the quality of tomato juice. Other important factors are variety and the supply of nitrogen. Fruits from low-nitrogen plants did not ripen as quickly or as evenly as those from medium vegetative plants and produced juice of a paler red color.

Control of diseases of vegetables.—Supplementing efforts to find disease-resistant varieties and strains of vegetables, the stations continued to give much attention to improvement of methods of using sprays and dusts for this purpose.

A practical means of controlling psyllid yellows, a serious disease of tomatoes and potatoes in certain Western States, is reported by the Colorado Station. It consists of spraying plants with a lime-sulphur solution containing 1 gallon of liquid lime-sulphur to 45 to 50 gallons of water. The station finds that tomatoes are more sensitive to spray injury than potatoes and therefore require more cautious treatment.

A disorder of garden beans commonly known as bean yellows, which develops on alkaline soils, has been effectively controlled by the Florida Station by spraying with manganese sulphate solution. Practical application of this information has eliminated the trouble as a major handicap to bean growing in the large producing areas of the State.

Bottom rot of lettuce, which has in the past caused annual loss of approximately one-third of the head lettuce produced on the muck soils of New York, has been found by the New York (Cornell) Station to be in large measure controlled by one application of 12 pounds per acre of an ethyl mercury phosphate dust to the surface of the soil beneath the plants 2 weeks before harvest. A special duster was designed by the station to facilitate effective application of the material.

The yield and quality of onions grown on muck soils were greatly improved by an application of 300 pounds per acre of powdered copper sulphate, in experiments reported by the New York (Cornell) Station. In comparison with onions with thin, pale yellow scales commonly produced on the muck soils, the treated onions produced bulbs with thick, well-colored outer scales. The tops of the treated onions were taller, greener, and matured later with a consequent increased yield.

Decay of spinach seed in the soil was reduced, in experiments reported by the New York State Station, and the yield of spinach was increased by coating the seed with red copper oxide, 3 ounces of the oxide sufficing to treat 10 pounds of seed.

Control of insect enemies of vegetables.—Sulphur and lime dusts were found by the New York (Cornell) Station to afford excellent protection of celery and other vegetables against the tarnished plant bug. The imported cabbage worm, the cabbage looper, and the diamond-back moth, insect enemies of cauliflower, were effectively controlled by the New York State Station with applications of ground derris root diluted with talc to provide a dust containing 0.5 percent of rotenone, the active toxic principle of derris.

Methods of protecting beans and cowpeas from weevils have been developed and published by the Tennessee Station, which finds that beans or cowpeas to be used for food may be protected by being thoroughly mixed with hydrated lime at the rate of 1 pound of lime to 1 bushel of seed. Beans or cowpeas stored for seed purposes may also be protected with lime or by mixing thoroughly with sodium fluosilicate at the rate of 1 ounce to 1 bushel of seed. Seed beans may also be protected by storing in airtight containers with flaked naphthalene or paradichlorobenzene at the rate of 1 pound to 50 cubic feet of space.

The possibility of breeding onions resistant to thrips, a very destructive insect enemy of this crop, was indicated by results of experiments by the California Station in commercial onion fields in which yields had previously been reduced as much as 40 percent by attacks of thrips. Strains of onions were found which show marked resistance to attack by thrips and furnish a basis for breeding for resistance. The New York (Cornell) Station found that 3 to 4 applications of a chipped naphthalene-hydrated lime dust scattered on the

rows gave good protection from thrips and resulted in increases in yield of from 50 to 100 bushels per acre.

Reducing the spray-residue hazard.—The New Jersey Station has found a derris-root dust mixture effective, but expensive, in control of cabbage insects. This station has also devised an effective method of removing spray residues from small fruits and vegetables as well as orchard fruits which is being used by growers.

Pyrethrum has been proposed as a possibly efficient substitute for insecticides which leave highly toxic residues. The Colorado Station reports that the plant can be grown economically in that State and that it has proved in the station experiments to be an effective insecticide.

Pyrethrum and derris sprays and dusts have been found by the Michigan Station to be effective in controlling most soft-bodied insects feeding on garden or truck crops at a cost not greatly in excess of that for arsenicals or fluorine compounds.

Derris-root dust has been found by the New Jersey Station to be very poisonous to many chewing and sucking insects, especially when applied on wet foliage.

Storage of vegetables.—From a study of the causes, character, and prevention of deterioration of vegetables in storage, the New York (Cornell) Station concludes that—

> In most instances the deterioration of vegetables in cold storage can be attributed to any one of three causes—chemical changes, wilting, or spread of storage diseases. Chemical changes are responsible for the rapid lowering of the eating quality of those vegetables which owe their taste largely to a high sugar content, such as sweet corn, asparagus, and peas. Although the rapid loss of sugar may be retarded considerably at a temperature of 32° F., these vegetables can be stored only for a very short time. Wilting causes deterioration of most of the leafy vegetables and root crops. Root crops may be stored successfully for 5 or even 6 months; the maximum storage period for leafy vegetables is much shorter and varies greatly with individual crops. Wilting can be delayed efficiently by maintaining a high humidity and a relatively low temperature. Storage diseases, particularly various types of mold, affect such crops as cucumbers, tomatoes, muskmelons, and squashes. Some diseases can be controlled by seed treatment and the elimination of diseased vegetables from storage.

Storing late-crop onions is, according to the Indiana Station, a very common and sometimes highly speculative operation in northern Indiana. The station therefore undertook to determine the best conditions for storage. It found the storage losses to depend largely upon the quality of the onions stored. It concludes that storage should be at a temperature as cold as possible without freezing the onions and as dry as possible without raising the temperature. Low temperature was found to be more necessary than low relative humidity.

Marketing peas.—From a study of the effects of methods of handling peas on their market quality, the New York (Cornell) Station has suggested various improvements of methods which would enable local growers to put a better quality of peas on the market and secure a better price in competition with western peas. Among the improvements suggested are maintaining the peas at a temperature of from 50° to 55° F. or lower from the time they are picked in the field until they are sold on the central market, and icing the refrigerator cars 24 hours before loading.

FLOWERS

The interest and activity of the experiment stations in production of high-value floricultural crops has greatly increased in recent years.

Asters.—Improved methods of growing asters for commercial purposes have been published by the Indiana Station. Greenhouse asters were generally superior to field-grown. Use of artificial light made possible the production of a midwinter crop of greenhouse asters of excellent quality.

Carnations.—The Illinois Station finds that carnations give materially lower yields when planted in old soil than when grown in new soil. When old soil can be treated with steam it may be kept in a highly productive condition for carnations indefinitely.

Chrysanthemums.—A new chrysanthemum sufficiently hardy to grow outdoors in Minnesota has been distributed by the Minnesota Station. Chrysanthemum plants of both the large-flowered and pompon types were found by the New York (Cornell) Station to bloom as much as 70 days earlier than normal if shaded with black cloth to reduce the day length to 11 hours. Early varieties were more sensitive to light treatments than were late varieties.

Gladiolus.—The California Station has found that the time required to bring gladiolus corms into blossom can be shortened from 2 to 6 weeks by electric heating of the soil to a temperature of 60°–70° F. Somewhat comparable results were secured by the Iowa Station by subjecting gladiolus corms to high storage temperatures (90°) prior to planting. The acceleration in blooming time ranged from a few days to 3 weeks, and there was no apparent difference in the quality of the flowers from the treated and untreated corms.

Hydrangeas.—Color control in hydrangeas has been a problem of interest to commercial florists. The New York (Cornell) Station finds that blue-flowered hydrangeas can be produced at will by applying a 2.5-percent aluminum sulphate solution to the soil during the forcing period.

Iris.—After many years of iris breeding by a member of the staff of the University of California, 1,400 successful crosses have been obtained which appear to produce normal seeds, and 14,440 seedlings have been brought to the flowering condition. Of the hybrids thus produced, 34 were registered, and all but 3 of the 34 have been introduced.

Nasturtiums.—The Indiana Station has found that the artificial lighting of nasturtium plants greatly increases the number of blossoms, with no sacrifice of stem length or earliness of bloom and with only a slight increase in production costs.

Roses.—In experiments reported by the Illinois Station roses gave materially lower yields on old soil than on new. Annual changing of rose soil, however, was found not to be economical.

Snapdragons.—Progress made by the California Station in the development of rust-resistant varieties of snapdragons forecast the restoration of successful culture of this valuable species and the possibility of bringing back to America the snapdragon seed-producing industry now centered almost exclusively in Europe.

Keeping cut flowers in condition.—The life of cut flowers, including roses, snapdragons, stocks, delphiniums, primroses, carnations, and others, was lengthened by the New York (Cornell) Station as much as 1 to 3 days by keeping them in copper-plated containers.

NUTS

Pecans.—Pecan rosette can be controlled, the Arizona Station reports, by application of zinc sulphate in the tree trunk or to the soil about the tree. More than 750 acres of pecan orchards in Arizona have been treated successfully and rosette eliminated.

Walnuts.—In a study of the extent and possibilities of walnut growing in Oregon, the Oregon Station found that the census of 1930 showed about 232,000 bearing trees in Oregon, but a more recent survey showed a considerable increase since the census figures were collected. Present cultural practices and ways in which they may be improved are indicated. The station has determined the cost of bringing a planting of walnuts to bearing age and the most economical methods of doing this.

In extensive experiments to control walnut blight, the California Station found prebloom spraying to be most effective. Spraying as late as June was of little value. An 8:4:50 bordeaux was used successfully at a cost of 2 cents per gallon of spray applied. Net profits from spraying were as high as $6 per tree.

Spraying of walnut trees with bordeaux mixture during the early nut-forming period, the California Station finds, will prevent to a considerable extent the development of blight. Zinc sulphate was found by the station to be effective in the control of walnut yellows.

FORESTRY

The work of the experiment stations in forestry is relatively limited because the Forest Service and other efficient agencies are available for research in this field. Several of the stations, however, have undertaken significant investigations in forestry, particularly in its more direct relations to agriculture.

Species adaptation.—The Alabama Station has determined where and under what conditions the different species of hardwoods and softwoods may be grown to the best advantage for timber, turpentine, and control of soil erosion. Loblolly pine was found to grow faster than the black locust and to be equally, or even more, effective in checking soil erosion.

Relation of forest growth to soil.—The Michigan Station finds that there is a rather definite relation between the soil type and the character of forest growth. The relation between soil characteristics and forest composition and growth appears to be sufficiently conclusive to establish general principles for forest land classification and silvicultural practices. Yield is quite definitely related to soil type, and many kinds of trees appear to be rather strictly confined to certain soil types.

Reproduction studies.—That direct planting is the only way of bringing about the reproduction of white pine forests on a commercial basis is the conclusion reached by the Vermont Station as a result of studies in thinning plats in white pine stands. Under natural conditions or with any of the types of thinning employed, birch and red maple tended to dominate the reproduction. When a

thinned area was heavily pastured by cattle the hardwoods were suppressed, and almost pure stands of white pine were secured.

Germination of basswood seed.—Difficulties in obtaining satisfactory germination of basswood seed due to physiological dormancy were successfully overcome by the New York (Cornell) Station by following a well-defined procedure. Seeds of high viability were stored in air-dry condition until 4 to 5 months before planting. They were then extracted from the fruits with concentrated nitric acid and the seed coats rendered permeable with concentrated sulphuric acid. The seeds were then stratified at 2° to 5° C. in moist sterile peat moss in open containers until germination occurred, when the sprouting seeds were transferred to the nursery.

Termite control.—Termites or "white ants", which may do great damage to wooden structures, have recently received considerable attention from a number of experiment stations. The University of California issued a book of 734 pages, prepared by 34 specialists, 13 of whom were connected with land-grant institutions, experiment stations, and the Department of Agriculture, dealing with termites—their destructiveness and their control. The Michigan Station published information on the construction of termite-proof structures, eradication of termites in the soil, and the treatment of timbers to prevent injury.

ANIMAL PRODUCTION AND PRODUCTS

The production and use of animals and animal products involve many and varied problems of breeding, feeding, care, and management of livestock on the farm, and the handling of the products from the farm to the consumer. The experiment stations are called on to deal with the subject in a specific as well as in a broad way.

A few recent accomplishments of the experiment stations in the field of animal production are cited here.

Horses and Mules

The question of efficiently and economically feeding and caring for farm work stock is constantly assuming greater importance. Particular attention is being given to the profitable use of local byproducts and other readily available feeds. A number of the experiment stations have recently reported investigations of this kind.

Cottonseed meal for horses and mules.—Young mules and colts fed cottonseed meal from weaning time at the Texas Station developed faster, shed their old hair better, and weighed more at 1 year of age than similar colts not fed this supplement. Mares fed 2 pounds of cottonseed meal were good sucklers and raised heavy foals. A ration containing 1 pound of cottonseed meal was palatable to 95 percent of the animals fed, and no particular difficulty was experienced in getting animals to eat 2 pounds. No injurious effects were observed when either 1 or 2 pounds of meal were fed daily, and when added to a ration not adequate in protein it was a useful, economical feed. Similar results were obtained in tests at the Tennessee Station. Over a 5-year period the Mississippi Station found that feeding 1.5 to 2 pounds of cottonseed meal per day per mule reduced the cost of the grain ration and improved the condition of the animals. In experiments with horses and mules of varying age, the Tennessee

Station found 1 or 2 pounds of 43-percent protein cottonseed meal to be a useful and valuable supplement to the rations used.

Wintering draft colts.—Attempts to reduce the cost of raising draft horses were undertaken by the Michigan Station. Results showed that corn fed in stalks or with shredded fodder was not a satisfactory feed for growing colts since they refused to eat the stalks and wasted a large part of the corn. It is recommended that such feeds be supplemented with legume hay and oats. Coarsely grinding grain increased the rate of gains of colts.

Pineapple bran for mules.—At the Hawaii Station mules were fed rations in which pineapple bran made up the principal part of the grain ration. This ration was as satisfactory and more economical than a ration in which barley made up the major part of the grain ration.

Beef Cattle

The problems of beef-cattle producers are many and complex. This is especially true in range-livestock production where overgrazing combined with devastating droughts have greatly reduced the carrying capacity and grazing value of the ranges.

Deficiencies of dry range forage.—The California Station finds that dry range forage may be deficient in protein, phosphorus, and vitamin A. Under normal conditions animals store enough of vitamin A during the green-feed season to tide them over periods when they must exist on dry forage. When, however, the green-feed season is short, insufficient storage of the vitamin takes place and in time symptoms of deficiency make their appearance. The deficiency is manifested by cows losing their calves before full term, by high mortality of new-born calves, by inflammation of the eyes, night blindness, discharge from the nose, intermittent diarrhea, and lack of gain. Providing animals with supplementary feeds rich in vitamin A was found by the station to overcome in large measure such difficulties.

Bookkeeping for ranchmen.—An effort to assist the ranchmen better to understand their costs of operation resulted in the setting up of a simple, effective system of accounting by the Nevada Station. This system has been of great help to ranchmen in that it shows the costs of the various operations, and, with some assistance from the station specialist, many have been able to reorganize their operations to reduce costs. The accounts have been helpful to bankers and loan agencies during the past few years and at the same time serve the purposes of investigation of ranch problems.

Whole cottonseed for cattle.—In cotton-growing areas the whole seed may be purchased from the gin at a relatively low price. Studies by the Texas Station in cooperation with the Department of Agriculture showed whole cottonseed to be an efficient and economical protein supplement to grain-sorghum rations for fattening steers. Whole cottonseed was used by the Arizona Station with favorable results when fed with alfalfa hay and ground barley to cattle, and also in combination with silage, alfalfa hay, and ground barley.

Soft corn as cattle feed.—Anticipating the possibility that the recent drought might result in the production of a large amount of soft corn in the Northwest, the South Dakota Station made experiments which showed that immature corn has considerable feeding value, steers making even larger gains on soft corn than with more mature

corn grown the same year; that shrinkage of steers receiving selected soft corn when shipped to market was not as large as it was with steers that received selected hard corn; and that soft corn put a good finish on cattle.

Silage as sole roughage for cattle.—Further experiments by the Kansas Station confirm previous conclusions that silage alone, if fortified with ground limestone at the rate of 0.1 pound per head daily, furnishes satisfactory roughage in cattle-fattening rations. The significance of this discovery lies in the possibility of pushing the cattle-fattening area farther to the southwest where sorghum crops are available for silage but where it was formerly thought that cattle could not be fattened satisfactorily because of lack of legume hays.

Tankage for fattening steers.—The great number of animals from drought areas that were fit only for tankage greatly increased the supply of this product. This fact, together with the competition for protein supplements from other sources, led to studies by the Ohio Station of the value of tankage for fattening steers. The results showed that when tankage furnished about one-half the protein of the ration, the rapidity of gain was increased from 6 to 10 percent and the cost of gains decreased slightly more, as compared with steers fed the same amount of protein of vegetable origin.

Quality of beef.—Difference of opinion as to the relative merits of beef from steer and heifer carcasses has led to studies of this question at several experiment stations.

Heifer carcasses produced by the Nebraska Station were consistently higher in fat, lower in muscular development, and the meat contained less water and protein than carcasses of steers fed similar rations. Periodic slaughterings of heifer calves full-fed corn and alfalfa hay showed that the dressing yield increased with increasing finish although there was little change in the percentage of the various cuts. The tendency of heifers to accumulate both internal and external fat was very marked and, because of the increasing wastiness, it seemed undesirable to full-feed heifer calves longer than from 150 to 175 days. In Iowa Station experiments heifer calves as a group were slightly fatter at the start and accumulated fat faster than steer calves. The heifer carcasses contained a high percentage of fat and a lower percentage of bone than corresponding steer carcasses. There were no consistent differences in quality of flavor of roasted prime ribs from steers and heifers similarly fed that could be attributed to sex.

Marked improvement was noted by the Nebraska Station in the dressing yield, covering, and quality of the carcasses of 12-year-old range cows with progressive fattening. Periodic slaughterings, over a 105-day feeding period, showed that gains made by these cows were slow and very costly, so far as feed expenditure was concerned. The fat content of the meat increased from 15 to 38 percent through the 105 days of full feeding. The color of fat changed from a yellowish amber to a creamy white. The improvement in the palatability and tenderness of the meat was particularly noticeable with increasing finish.

Dairy Cattle and Dairying

The dairy industry is faced with varied and ever-changing conditions furnishing fruitful fields for investigation. The producer must

always be on the lookout for means of improving the quality of milk at a reasonable cost, while the dairy manufacturer must meet an ever-increasing demand for dairy products of kind and quality acceptable to consumers.

Prices and consumption of milk.—There is general agreement that a higher consumption of milk would raise the general level of health, and this gives a good basis for encouraging the greater use of milk. On the other hand, the Illinois Station finds abundant evidence of the futility of trying to sell greater volumes of milk at prices that consumers do not consider in line with the prices of other foods. Consumers will probably continue to compare retail prices of milk with prices for butter, eggs, meat, and other foods which they use daily. If they are to be induced to use more milk, prices must be kept at a level which consumers consider reasonably low in relation to prices of competitive foods.

Cost of producing milk and butterfat.—In the long run, as the Rhode Island Station points out, the interests of the consumer will be better served by the maintenance of fluid-milk prices at a point which will enable the farmers to continue in business and produce an adequate and regular supply of milk. In order to help farmers organize their business on a substantial basis many experiment stations have undertaken studies to determine the factors involved in the profit or loss of the dairy farmer.

Six cents per quart was established by the Rhode Island Station as the average cost of producing milk on Rhode Island farms in 1933. An analysis of costs was made by the station to enable both the producer and consumer to understand more clearly the necessary costs involved and why a price to cover these costs and to insure a reasonable profit is justified. The station points out that farmers cannot withdraw from milk production quickly and if prices continue much below cost for a considerable period they may be forced out of business with a serious reduction of milk supply. Temporary low prices for milk may seem to be an advantage from the consumer's standpoint, but in the long run the interests of consumers will be better served by maintenance of prices which will enable dairy farmers to continue in business and produce an adequate and regular supply of milk.

The average cost per pound of producing butterfat in Oregon was found by the Oregon Station to be 36 cents for the year ended April 1, 1932, as compared with 50 cents for the year ended April 1, 1930. The principal cost items were feed, 52 percent, and labor, 27 percent. The main factors affecting cost were yield per cow, available pasture, price of grain and hay, size of herd, and labor efficiency. An advantageous reorganization of business management on over 500 dairy farms as a result of the station work during the first year is reported.

Records of the cost and returns of milk production secured by the Virginia Station from 134 dairymen supplying milk to the city of Norfolk showed that very few of the dairymen secured a plus labor income. The group of dairymen with the highest-quality herds, the smallest size of business, and the lowest capital investment in the farm business on which interest must be allowed, secured the largest plus labor income in spite of lower labor efficiency. Large size of

business was profitable only when dairymen maintained high-quality herds and took advantage of the many opportunities offered by larger size for greater efficiency.

Records obtained by the Michigan Station from 74 cow-testing associations showed that the group with the lowest average butterfat production operated at a loss, while the group with the highest average butterfat production showed a substantial profit per cow. The results indicate what the individual dairyman can do by adopting a well-balanced program, even though he can do little individually regarding price of product.

One of the largest items of cost in milk production is grain and other concentrates. Reducing this item of expense is of great advantage to the dairyman. Comparatively high-producing cows, the Wyoming Station finds, can be kept in production and in a good state of health for several years without grain or any other concentrate, provided they get an abundance of alfalfa hay and are pastured during a short season in the spring and summer on mixed grasses and sweetclover. This eliminates the most expensive item of dairy rations. Where the winters are shorter or less severe, still further feed economies may be effected.

Year-round pasture experiments with dairy cattle reported by the Tennessee Station showed more economical milk production without the usual concentrates than with them. In 1933 the year-round pasture furnished the equivalent of 300 days of pasture. When the animals were not on pasture, either alfalfa hay or alfalfa hay and silage was fed. Such information is of value in agricultural adjustment because it indicates the practicability of using land that has been in cultivation for the production of hay and pasture. It also shows that it is safe to feed dairy cows on alfalfa hay without supplements of grain or other concentrates and that fairly high production can be maintained under this system of feeding.

Effect of time of freshening.—The economic advantage of having some of a herd of cows freshen in the late fall months has been demonstrated by the Nevada Station because (1) the butterfat test is highest during the winter months, (2) the production per cow is greatest when they freshen late in the year, and (3) the price received for milk and butterfat averages higher in the winter than in the summer months.

Soybeans for dairy cows.—The soybean is being grown widely and to an increasing extent both as a regular and as an emergency crop. Because it can be grown easily over so wide a territory and has such a high protein content, the Illinois, Indiana, Iowa, and Ohio Stations, among others, have been led to investigate its value as a feed for dairy cows as well as other kinds of livestock. Both the hay and the beans, preferably cracked beans, have been shown to be valuable dairy feeds, comparing favorably with other legume hays and protein concentrates. The use of the beans reduces materially the need for purchased feeds.

Alfalfa vs. grass hays for dairy cows.—Alfalfa hay was demonstrated to be superior to timothy hay from the standpoint of milk production in experiments by the Virginia Station and the Department of Agriculture, and the nutritive value of the timothy-hay ration was not improved simply by balancing the protein, but when,

in addition, inorganic calcium was fed with the timothy hay, there was decided improvement. Similarly, prairie hay was found by the Kansas Station to be equal to alfalfa hay when both protein and minerals were balanced in the ration.

Phosphorus requirements of dairy cattle.—In certain parts of the country soils and plants are deficient in phosphorus and it is necessary to furnish this element in the feed in order to maintain the normal functions of the animal body. Results of investigations by the Michigan Station indicate that the phosphorus requirement for milk production and reproduction is 0.7 g of phosphorus in the food per pound of milk produced. The station recommends 0.75 g of food phosphorus per pound of milk above maintenance to allow for individual differences of cows and variations in the phosphorus content of the milk. Not less than 17 g of phosphorus should be fed daily during low production and dry periods and when cows are in an advanced stage of gestation.

Abnormal flavors in milk.—Abnormal flavors often constitute a major problem in the production and sale of fluid milk. They cause a loss in sales and even when not very pronounced result in decreased consumption. Investigations reported by the New York (Cornell) Station indicate that feed is not the sole cause of off-flavors in milk, but that individuality of the cow is also an important factor. Milk from different quarters of the udder was found to vary in the intensity of developed flavor. Most of the cows producing off-flavored milk in winter did not produce such milk in summer.

Effect of pasteurization.—Investigating the influence of the temperature of the heating medium on the creaming and flavor of pasteurized milk, the New York State Station found that milk could be heated during pasteurization to a much higher temperature than is generally supposed to be possible without producing cooked flavors. For other reasons, however, the station advises that the temperature be held at a minimum. Some loss of the antineuritic vitamin B and the antipellagric vitamin G was observed by the Pennsylvania Station in all methods of pasteurization, but under carefully controlled conditions this loss was not large.

Use of dried skim milk.—Many attempts have been made to increase the utilization of byproducts of the dairy industry. Particular success has been attained in the use of dried skim milk in the preparation of other dairy products and for other purposes (p. 83).

The addition of small amounts of dried skim milk to normal skim milk prior to fermentation in the manufacture of cultured buttermilk was found by the Alabama Station to increase the viscosity and improve the flavor and consistency of the resulting product. The flavor, aroma, and desirable physical properties of such buttermilk could be maintained for several days at a storage temperature of from 35° to 38° F. The Missouri Station found that adding 6 percent of dried skim milk improved cream for whipping purposes by imparting a more desirable flavor; giving a closer, more uniform, and smoother texture; increasing the resistance of the body and reducing the material that drained from the finished product; imparting a more glossy, desirable appearance; and developing a whipping quality in creams that would otherwise be undesirable for this purpose. Favorable results were also obtained by use of dried skim milk in the manufacture of cream cheese and cottage cheese.

Increasing the vitamin A content of butter.—It has been suggested that if butter could be marketed with a uniformly high content of vitamin A the consumer would profit materially thereby.

The dairy cow is apparently not efficient in transferring the vitamin A of her feed to the butterfat she produces, the Texas Station finds. In the station's experiments 1 unit of vitamin A in butter required about 11 units in the feed over maintenance. In order to maintain a high vitamin A content in the butterfat the feed of the cow must be high in this vitamin. Silage and ordinary hays and fodders apparently do not supply enough vitamin A to maintain a high level of the vitamin in the butterfat. Green, growing pasture grasses appear to be needed for this purpose.

Under winter feeding conditions the Indiana Station found that timothy hay produced a butter of low vitamin A content while good-quality alfalfa or soybean hay were effective in maintaining a high vitamin A content in the butter. Evidence was obtained that the vitamin A content of butter responds rapidly to that of the feed.

Cheesy flavors in unsalted butter.—Unsalted sweet-cream butter is sometimes tainted with cheesy flavors. Methods of preventing such flavors have been worked out by the Minnesota Station and are now being adopted by creameries making sweet-cream butter. As a result losses in butter have been avoided and better prices obtained.

Standardization of Iowa butter.—The Iowa Station made monthly chemical analyses of butter manufactured in 129 Iowa creameries to aid in securing a product that would be of uniform composition and contain from 80 to 81 percent butterfat. When this work was started some creameries were not meeting the legal requirement of 80 percent butterfat, while others manufactured butter of irregular composition. As a result of the work of the station, the butter from most of the creameries has become more uniform, with a substantial annual saving to the creameries.

Tallowy flavors in strawberry ice cream.—Tallowy or stale metallic flavors in strawberry ice cream offer a problem of considerable commercial importance. While the cause is not yet fully understood, such off-flavors have been attributed to oxidation of the butterfat and contamination of the ice-cream mix with copper from containers and utensils used in the processes of manufacture. The remedy proposed by the Kansas Station is to reduce contamination to the minimum, use only dairy products of the highest quality, and add 15 percent or more of solid packed berries, homogenizing the mixture at high pressure (5,000 pounds).

Strawberry ice cream made with condensed skim milk as a rule contained more copper and developed tallowy flavor more quickly than ice creams made with dried skim milk, in experiments reported by the Iowa Station.

Higher aging temperatures for ice cream.—The Massachusetts Station has shown that an initial aging temperature of 68° F. for 6 hours greatly increases the viscosity and gel strength of ice-cream mixes. There was no definite increase in bacterial content until after 10 hours in mixes aged at 68°. Aging at such a temperature appears to be practicable and advantageous in the commercial manufacture of ice cream.

Sterilizing dairy utensils.—The sanitary condition of equipment used in handling of milk is of great importance in maintaining the

quality and preventing losses of the product. Extensive trials by the Vermont Station under practical dairy-farm conditions showed a noticeable improvement in the quality of milk when utensils were treated with chlorine solutions.

Electrically heated dairy-utensil sterilizers have been so improved in design by the Pennsylvania Station that they are capable of meeting the requirements of the Pennsylvania Department of Health for sanitary milk. With the improved equipment it is possible to obtain a temperature of 215° F. with a very small amount of water and to reach this temperature in a relatively short time.

Exposing milk cans for 8 seconds to the full blast of a gas-torch flame that attained a temperature of 1,950° F. was found by the New York State Station to reduce the bacterial contamination from 600,000,000 to 500 bacteria per can. Such treatment appears to be economical and effective, particularly in connection with the large power can washer.

Hogs

Profound changes in market requirements and the narrow margin of profit to hog producers have emphasized especially the need of greater efficiency and economy in pork production. The experiment stations have recently reported a number of investigations having this object primarily in view.

Production of pork at low cost.—The value of forage in the swine-production program was again emphasized in further studies at the Alabama Station. It was found that fall-farrowed pigs could be raised and finished at a low cost by grazing them on winter legumes, such as Austrian winter peas and hairy vetch, in addition to a ration of oats or corn and either tankage or fish meal and a suitable mineral mixture.

Hog market prices.—A program of hog marketing checked by farm accounts has been worked out by the Kansas Station and is showing the importance of hog raisers being adequately informed as to market prices. Comparing the percentage of annual hog sales occurring each month with the percentage of total movement of Kansas hogs to all markets, it was found that the farmers receiving the marketing information usually marketed the largest proportion of their seasonal supply of hogs at the time that Kansas producers in general marketed the smallest proportion of their seasonal supply. It was found that members of this group of farmers sold more hogs closer to the seasonal high prices and a smaller proportion in periods of the lowest seasonal prices than Kansas farmers in general. Shifts from the normally weak price periods tended not only to benefit the particular group so shifting through better prices but to benefit producers in general.

Inbreeding Berkshire swine.—Attempts to fix type in swine through inbreeding have been tried with varying success in the past. Experiments by the California Station with brother-sister matings showed that this practice did not result in a decrease in litter size. Over the period from 1919 to 1926 the average size of 71 noninbred litters was 8.1, as compared with 9.8 per litter from 18 inbred sows during the period 1922 to 1931. The type of the inbred pigs was relatively uniform, and no abnormalities or color changes were observed.

Pigs on alfalfa pasture.—For the limited feeding of spring pigs on alfalfa pasture, the addition of 8 percent of tankage to wheat proved to be more economical in both rate and economy of gain than wheat alone, in experiments reported by the Montana Station. When finished in the dry lot the wheat-and-tankage pigs made more rapid and cheaper gains than the pigs fed wheat alone. Wheat alone did not prove to be as satisfactory a ration for growing pigs on alfalfa pasture or finishing in the dry lot as a ration of wheat and 8 percent of tankage.

Oats as feed for swine.—The Illinois Station finds that oats can be used in place of corn in rations of pregnant sows without noticeably reducing the efficiency of the ration. They may also be used, but to a less extent, in rations for sows during the suckling period. Grinding the oats increased their efficiency. Hulling for growing-fattening pigs was less profitable than grinding. The station concludes in general that only when oats are as cheap as corn will they produce as cheap gains as will a ration of corn and a protein supplement.

Molasses as a feed for hogs.—Cane molasses has been found to be a palatable low-protein feed for hogs and to increase the consumption of less palatable feeds. Results of experiments by the Hawaii Station indicate that when fed in amounts up to 20 percent of a ration for fattening hogs, cane molasses was worth about as much pound for pound as rolled barley. Use of the molasses in this way furnishes an additional outlet for an available byproduct and reduces the producer's costs.

Cottonseed meal for hogs.—The safe and efficient use of cottonseed meal as a feed for hogs has received much attention by the experiment stations. It is generally recognized that the meal has certain nutritional limitations, particularly for swine.

Substitution of cottonseed meal for one-half of the usual quantity of fish meal in the swine-fattening ration, in experiments reported by the North Carolina Station, resulted in an increase in the daily gain of about 12 percent and a decrease in the unit cost of gain of about 4.5 percent. Feeding a ration containing 13 percent of cottonseed meal successfully corrected softening of carcasses resulting from feeding of peanuts, and produced normal gains. The economic and industrial significance of these results is evident. Cottonseed meal has also been shown by the Mississippi Station to be a valuable protein supplement in finishing hogs. The Ohio Station considers it to be a safe and satisfactory source of protein for pigs if (1) combined with half as much tankage, or (2) moistened and autoclaved, or (3) treated with a solution of iron.

Sweetpotatoes as a hog feed.—Sweetpotatoes were found by the Georgia Station to produce unsatisfactory gains as compared with corn when fed in dry lot with protein and mineral supplements. When a limited amount of corn was fed with sweetpotatoes in this way the results were fairly satisfactory. Grazing of sweetpotatoes gave better results than feeding them in dry lot. It was observed that sweetpotatoes showed a strong tendency to overcome softness of pork, being superior to corn in this respect.

Soybeans and soft pork.—Soybeans have been shown to be a valuable feed for swine, except for their tendency to produce soft pork.

Growing and fattening pigs, fed by the Iowa Station from soon after weaning time to an average final market weight of 225 pounds,

produced soft fat when appreciable amounts of whole soybeans were fed along with corn and mineral mixture, on rape pasture or in dry lot. The degree of softness of the fat varied with the amounts of soybeans fed.

Soft pork was not produced when spring pigs were grazed on immature soybeans, supplemented with corn, fish meal, and a mineral mixture, in experiments reported by the South Carolina Station. This was found to be an economical way of finishing hogs. Biloxi, a late-maturing variety of soybeans, proved especially suited to such use.

Quality and palatability of pork.—In experiments reported by the Nebraska Station, cooperating with the Department of Agriculture, pigs fed corn and a mineral supplement in dry lot showed progressive increases in live weight, but this did not materially influence the palatability of the roasts except to increase their juiciness. Pigs fed corn, soybeans, and tankage lacked finish and produced soft carcasses. Where soybean oil meal was substituted for the soybeans, firmer carcasses were produced than with soybeans. No significant differences in palatability were noted between roasts produced upon the various rations. Pigs receiving 6 percent of ground soybeans averaged medium soft, while those fed cottonseed meal were graded hard. None of the feeds used had any serious softening effect upon the lard. The lard produced where cottonseed meal was fed was noticeably firmer.

Because of the mild climate and changeable weather the curing of meat on farms in the South has been extremely hazardous. Results obtained in experiments at the Alabama Station indicate that pork can be cured on the farm in an iced brine solution even in summer. Preliminary trials indicated that 200 pounds of ice, 40 pounds of salt, 10 pounds of sugar, and 2 ounces of saltpeter were necessary to cure each 100 pounds of meat, but later tests showed that the amount of ice and curing ingredients may be reduced one-half. The cost per pound of cured meat, using the smaller amounts of ice and curing materials, was 0.75 cent. For success in this process sanitary methods and thorough chilling of the meat during the 24 to 48 hours immediately following slaughter are necessary.

Sheep

Investigations in sheep production are complicated by the fact that quality and efficiency of production of both meat and fleece must be considered. Many breeding, feeding, and management investigations with both of these subjects in view have been reported by the experiment stations.

Breeding sheep for greater productive and reproductive capacity.—The possibility of increasing the number of functioning nipples in the udder of ewes and thereby furnishing more milk for twin lambs was realized many years ago by Alexander Graham Bell. Since his death, the New Hampshire Station has continued investigation of the subject, using breeding animals acquired from Dr. Bell. The character of four functional nipples has in large measure been fixed by breeding over a number of years. Crossbreeding has been carried to the point where it is possible to define the mode of inheritance of this character. Other objects of this study, namely, increase of

capacity for wool and mutton production and fixing of the twin-bearing character, have also been largely attained. On the basis of the results of these investigations, the station has tentatively proposed a method of breeding which it is thought will greatly simplify the development of a new strain highly productive in wool and mutton, having four functional nipples, and bearing largely twins.

Hornless Rambouillet sheep.—Investigations were undertaken by the Texas Station to fix the hornless or polled character found in certain strains of Rambouillet sheep. The results of these studies have made it possible to place the breeding of polled Rambouillets on a sound scientific basis. It is now possible by sire tests to develop flocks free from the polled character.

Timothy hay versus legume hays for sheep.—Timothy has long been considered an unsatisfactory roughage for sheep, but studies at the Ohio Station have shown that early-cut timothy hay with protein and mineral supplements can be satisfactorily substituted for legume hays. In experiments with growing wether lambs, the New York (Cornell) Station found little difference between the nutritive value of the protein of alfalfa hay and that of clover hay when fed in a balanced ration.

Limestone in sorghum rations for fattening lambs.—Results of experiments by the Texas Station showed that the inclusion of limestone flour or pulverized oyster shells in sorghum rations otherwise low in lime resulted not only in a considerable increase in gains but in producing better-finished carcasses. Approximately 0.4 ounce of the mineral supplement per head daily appeared to be a suitable amount to use in the sorghum ration.

Silage for bred ewes.—Silage supplemented with grain, soybean-oil meal, and steamed bone meal was equal, if not superior, to a ration of grain and alfalfa hay for bred ewes. The animals fed silage gained more weight up to lambing than ewes fed alfalfa. There was no significant difference in the vigor or weights of lambs at birth or in the fleece weights of the ewes. In this study the silage ration was the more economical.

Quality and palatability of lamb.—Slaughterings of average animals made every 28 days, in experiments reported by the Nebraska Station, showed a consistent improvement in live and carcass grade of lambs as a result of fattening. Fat animals on maintenance rations reversed this process. Full-feeding produced roasts with a more desirable aroma and flavor. Full-fed lambs on maintenance rations produced roasts of lower palatability, especially as regards flavor and aroma. Lamb produced with wheat was fully equal in quality and palatability to that produced with corn.

Improving the quality of wool.—In cooperation with a leading breeder of fine-wool sheep, the Wyoming Station is conducting an experiment to determine what improvement in the quality of fine wool grown in the Western States may be produced by the introduction of Merino blood from Australia. So far as the experiment has gone, it indicates that a distinct improvement in the quality of wool with respect to length, uniformity, softness, and brightness may be expected from the use of the Australian blood. The fleeces of the animals originally imported did not deteriorate in the new environment. They still have the qualities that cause American manufac-

turers to import a considerable amount of the best Australian wool even in years when the domestic clip of fine wool appears to be adequate for the ordinary domestic needs. The manufacturers use these special types of Australian wool to produce goods of fine texture and finish which they claim can be manufactured only from these special types of wool. The results of breeding native ewes to the Australian ram indicate that the wool of the native Rambouillets can be rapidly graded up to approach the standards of the Australian purebreds. The Australian sheep were also efficient producers of wool.

Poultry

Poultry production both as a commercial and as a farm enterprise is a widespread industry. Varied climatic and other environmental conditions and the pressing need of increasing efficiency and profits of production, and improving the quality of product, have made this a leading field of investigation by the experiment stations. Breeding for improved stock; better methods of feeding, care, and management, and disease control; and production and marketing of a product more acceptable to consumers, and hence commanding a better price, are some of the many important poultry questions investigated by the stations.

Breeding for egg production.—In breeding experiments for high egg production with Rhode Island Reds, the Massachusetts Station found that the ability to lay large eggs at an early age and to lay late in the fall is highly important. The station's experiments indicate that the poultryman can select pullet breeders that have attained the 24-ounce-per-dozen egg weight in the shortest time after the first pullet egg with considerable assurance that such birds will be persistent breeders. A systematic plan to aid poultry breeders in increasing the egg-producing ability of Rhode Island Reds has been worked out by the station as a result of many years' effort to determine the influence of various factors concerned in egg production.

Cooperative community marketing of eggs.—The Indiana Station reports success of a simple, economical, and practicable system of egg marketing developed by a community cooperative-marketing association organized by producers under the guidance of the station. The plan, which is considered not only simple but flexible and adaptable in other communities, is in brief as follows:

> The eggs are gathered, graded, and packed in standard cases at the farm. An uniced refrigerator car is set on the railroad siding the day prior to the day of loading. Each farmer tags his cases and consigns them to his selected receiver in New York City. He delivers his cases of eggs directly to the car, where they are loaded under supervision of the manager, who collects cost of freight and expense of loading. At a definite time on the day of loading (Monday) the car is closed, sealed, and picked up by a fast freight train. Upon arrival at New York, approximately 55 hours from the time it leaves the loading point, the car is unsealed by a bonded trucking company to which it has been consigned. This company delivers the cases to the receivers specified on the cases. From 10 to 15 receivers get the eggs from each car. The receivers separate each individual's eggs and draw samples to determine the price to be paid. The farmers get their checks about 5 days after shipping.

Prices are paid according to quality of product, which gives an incentive to produce clean, full-bodied, sound eggs of good size.

Consumer preferences in eggs.—In a further study of consumer preferences in the New York market, with particular reference to

eggs from Missouri and other Midwestern States, the Missouri Station found that the much lower price for the western eggs was due to relatively poor quality and trade discrimination against brown shells and medium to dark yolks. Means of improving the quality and overcoming false prejudices are suggested by the station.

Hatching quality of eggs.—The Kansas Station finds that there is a tendency for hatching quality of eggs to decrease with the age of the hens producing them. Heavy egg production was not found to impair the hatching quality. Pullets pausing during the period previous to the hatching season produced eggs of better hatchability than did those laying continuously throughout this period. Close inbreeding impaired the hatching quality, while outcrossing improved it. Hatchability varied inversely with the size of the egg. Under the experimental conditions maintained, holding eggs longer than 6 days appeared to be detrimental. There was some indication that under certain conditions hatching quality of eggs was impaired by low temperatures before the eggs were placed in the incubator.

High temperatures during the summer months and low temperatures with sudden changes in the winter months was found by the Kentucky Station to cause poor hatches. High egg production was not harmful to hatchability. Pullet eggs hatched better than hens' eggs. Large egg size was associated with low hatchability. Crossbreeding improved hatchability. Eggs laid in the afternoon hatched better than those laid in the morning. Hatchability decreased with the age of the eggs when held longer than 14 days. Chicks which were slow in hatching were evidently low in vitality.

Effect of confinement brooding.—Pullets and cockerels raised with access to sunshine and grass range were found by the Kentucky Station to be more vigorous, active, and healthy in appearance than those raised indoors without direct sunshine during a period of 22 weeks, and laid more and larger eggs.

Management of pullets in confinement.—The Ohio Station found that when chicks 2 or 3 weeks old were put on range on which pullets had been kept continuously they developed a certain degree of resistance to infection. On the other hand, when chicks and growing pullets which had been protected against infection by confinement indoors, in batteries, or on wire sun porches for several weeks were put on such ranges or subjected to other sources of infection they were highly susceptible to disease, with disastrous results from the standpoint of egg production. This suggests that chicks may have an inherent resistance to certain contaminations or that they may be more capable of developing such resistance when exposed at an early age. In either case it appears that pullets raised in confinement until 7 to 12 weeks of age are unprepared to withstand exposure to contaminated range or other sources of contamination and that extreme caution should be exercised to protect them against such exposures.

Rice products for poultry.—Results of experiments by the Arkansas Station indicate that rice products can be included in the laying and growing rations for poultry with satisfactory results provided a good source of growth-promoting anti-infective vitamin A is furnished as a supplement. Since rice byproducts are commonly lower priced than other feeds in Arkansas, particularly in the rice terri-

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tory, the use of these feeds enables poultrymen to produce both eggs and meat at lower costs. Cod-liver oil was found by the station to be a valuable supplement to rice-byproduct rations and reduced the need for other grain feed.

Rice bran, rice polish, and brewer's rice, the Louisiana Station finds, can be used to replace high-priced feeds such as wheat, bran, oats, and corn products. The use of rice byproducts reduces the cost of poultry rations from 10 to 20 percent. It is estimated that the use of rice byproducts to replace feeds shipped from out of the State would save the poultry industry of the State $100,000 a year.

Oats as a poultry feed.—The Indiana Station found 30 percent of ground oats to be as satisfactory as 15 percent, each, of wheat bran and wheat middlings in rations for growing chicks. The South Carolina Station has found a mixture of yellow corn 70 pounds, oats 15 pounds, and wheat 15 pounds with a mash mixture of 100 pounds each, of ground oats, yellow corn, wheat middlings, wheat bran, and meat scrap to be a very effective poultry ration.

Sorghum as poultry feed.—Grain sorghums where available are used as poultry feed and with generally good results, except when the grain has been damaged by weather or improper storage, according to the Kansas Station. Results of experiments by the station did not substantiate "the old belief that kafir and milo have 10 percent less feeding value than corn." The station concludes that "good-quality kafir or milo can replace either white or yellow corn pound for pound in a ration for growing chicks and laying hens when adequately supplemented with other nutrients" and recommends poultry rations containing grain sorghum, especially when the sorghum is cheaper than corn.

Pimientos as feed for poultry.—The feeding of dried and fresh pimientos to poultry, the Georgia Station finds, intensifies the color of the yolks of egg produced and of the shanks of young chickens. By regulating the amount of pimiento fed, the yolk color may be adjusted to market preferences. Heretofore a very large tonnage of small, defective, and scrap pimientos has gone to waste at canneries. Now that it is known that this waste can be dried and sold for use in poultry-feed mixtures, the canneries have a new and profitable outlet for a waste product for which there is an increasing demand.

Peanuts for laying hens.—In an experiment to determine the value of whole peanuts, ground peanuts (with and without shells), and peanut meal in rations for farm flocks of laying hens, the Alabama Station found that ground peanuts may be used satisfactorily to replace one-half of the protein supplement in the basal ration with good results in egg production. The birds produced at the rate of 16.3 and 15.5 eggs per bird per month in two successive yearly tests. Alabama produces approximately 10,000,000 bushels of peanuts annually. In recent years overproduction has resulted in low prices. It now appears to be possible, as a result of work of the station, for farmers to use surplus peanuts to advantage in poultry rations and thus reduce the cost of production by substituting a home-grown feed for other and more expensive forms of protein supplements.

Fish meal for poultry.—Alaska herring fish meal has been found by the Washington Station to be an excellent source of protein for growing chickens. In the station's experiments it was substituted

for skim-milk powder with the result that excellent growth of chicks was obtained at a greatly reduced cost. This information has been made available to the poultry industry of the State and as a result a large proportion of the chick rations now used is mixed according to the formula recommended by the station, with a saving of approximately $4 per ton of feed.

Vitamin requirements for growth and egg production.—Young pullets, both high and low producers, nearing the end of the first 4 months of production, laid eggs with yolks of similar vitamin A content, in experiments reported by the Kansas Station, but the eggs had dissimilar contents of this vitamin near the close of the first year of egg production. Eggs from low producers at that time showed 33 units of vitamin A per gram of yolk as compared with about 20 units in eggs of high producers, the eggs of high producers having decreased and of low producers increased in vitamin A content.

Inclusion in the rations of laying hens of any one of several materials rich in vitamin D, the Iowa Station found, could be depended on to increase markedly the vitamin D content of the egg yolk at a very small additional cost provided the more efficient supplements are used.

The vitamin D requirements of growing chicks and laying hens have been studied in some detail by the Pennsylvania Station. The station found that Single Comb White Leghorn chicks, reared in battery brooders deprived of sunshine and fed an all-mash ration deficient in vitamin D but adequate in other respects, developed rickets at 3½ weeks of age. The difficulty was overcome in each case by addition of fortified cod-liver oil to the ration, with satisfactory results in maintenance of body weight, egg production, size of egg, quality of eggshell, and hatchability. (See also p. 75.)

Factors affecting market quality of eggs.—Eggs from hens fed cottonseed meal, in experiments reported by the Michigan Station, deteriorated in storage through the development of spotted yolks and "pink" whites and yolks. The olive yolks were traced to the presence in them of gossypol which came from the cottonseed meal of the ration. The station finds that eggs believed to be from hens fed cottonseed meal may be tested rapidly by placing the yolk in an atmosphere of ammonia. This hastens discoloration and makes possible the elimination of eggs not suitable for storage purposes. Feeding soluble iron salts was found to retard olive discoloration but not to prevent pink discoloration. Eggs produced by hens fed cottonseed or cottonseed meal were found to be lower in quality than those not so fed, as evidenced by olive-colored yolks, in studies at both the Louisiana and New Mexico Stations. Such eggs are unsalable, and farmers are advised not to feed cottonseed meal to laying birds.

There was practically no difference in the quality of eggs produced by hens fed various cereals, in experiments reported by the Wyoming Station, except that yellow corn produced a deeper yellow color of yolk, which is considered undesirable in some markets but highly desirable in others, and that rye, although satisfactory from the standpoint of quantity production, resulted in an egg which appeared to be prematurely old. A ration containing a large amount of rye should not, therefore, be used for producing eggs for a fancy

market where quality is an especially important consideration. The low quality was in appearance only and there was no bad flavor or other real defect. Yolk color was found by the Kansas Station to be deepened by feeding yellow corn or green wheat. The eggs produced on green wheat were quite uniform in flavor.

Rough handling of eggs during transportation results in considerable deterioration in quality, the New Mexico Station finds. Both age and temperature were also shown to have a very definite effect in lowering the quality of high-grade eggs and in intensifying defects in eggs attributable to faulty production practices. Holding eggs on the farm at an average temperature of 68° F. for 12 days or more lowered quality as did the use of green feed (alfalfa or wheat). Fertile eggs declined in quality more rapidly than infertile. The quality of eggs shipped with the small end down was better than that of eggs shipped with the small end up. Eggs shipped by truck were of better quality than those shipped by refrigerator freight or by express.

From a study of the relation of quality to retail price of eggs in New York City, the New York (Cornell) Station found a wide variation in retail price not necessarily related to actual quality of the eggs. For example, in general, New York City consumers paid a premium of 3 to 5 cents per dozen for white-shell eggs over brown-shell eggs, and a premium of 1 to 4 cents for brown over mixed colors. These average premiums were primarily a result of the relatively low prices paid for brown eggs and mixed colors of low quality. For eggs of high quality the price was approximately the same, regardless of shell color. The price, however, was affected by cleanliness of the shell, uniformity of size, and physical appearance of the contents.

Candling as a means of grading eggs.—The efficiency of candling as a means of grading eggs has been fully investigated by the California Station. These investigations showed that initial quality and keeping quality may vary greatly from egg to egg but to a relatively small extent in the eggs from the same hen. It appears, also, that even with perfectly consistent grading by candling, or by any other method, eggs originally all of one grade, because of the wide difference in their keeping powers, will be found distributed in part through several lower grades after storage or shipment. This variation in quality cannot be eliminated by the present methods of grading.

Turkey-production costs.—An average cost of producing turkey meat of 39.2 cents per pound (dressed weight) was established from information secured from turkey growers by the Rhode Island Station. Marketing costs were a little over 6 percent and production costs about 94 percent of the total cost. Since production costs are so high the Rhode Island grower is being urged to improve his system of management to reduce cost of production. The grower can do little to change the prices of the feed and other supplies which he buys, the wages of hired labor, or the overhead charges on investments already made. However, he can control very largely the selection of the breeding stock or the source from which eggs or poults are obtained, the selection of the feeds used, the feeding practices followed, the use of labor, and decisions regarding the investment of

funds in the turkey enterprise. This is where business judgment and management can be applied most effectively to control costs.

Propagation of ring-necked pheasants.—The supply of many wild game birds is declining to an alarming extent. It is evident that natural propagation cannot be depended on to maintain or increase the supply. The Pennsylvania Station, among others, has undertaken to determine whether ordinary methods of artificial incubation and brooding can be adapted to the commercial propagation of wild species. Modifications of incubation and brooding as practiced with chicks have been adapted successfully to pheasant rearing by the station, which has thus been enabled to give practical directions for the incubation, feeding, and care of young pheasants.

FISH AND OYSTER CULTURE

Fish culture.—The Minnesota Station has published results of a study of the possibilities of developing the fish resources of the lakes of the State, with special reference to available fish food.

Conditioning oysters.—The New Jersey Station states that the proper conditioning of oysters for market is a most essential part of the cultural problem. This means providing conditions which will enable oysters to rid themselves of deleterious and irritating materials which they acquire from sand or mud bottoms on which they grow and overcome injuries sustained in the dredging process. "Floating" in fresh clean water, as it has heretofore been done, has not proved entirely satisfactory and is a serious problem. Freshening in closed tanks in which clean salt water of the proper temperature and salinity was pumped was used by the New Jersey Station with encouraging results.

Animal Diseases and Disorders

Animal diseases and disorders play a large part in determining the efficiency and economy of farm production and the quality of the product supplied to consumers. Not infrequently they are the limiting factor. Consequently, the experiment stations as well as the Department of Agriculture give much attention to questions of animal health, especially as related to the economy of production and quality and wholesomeness of the product. A few examples of such work recently reported by experiment stations follow.

HORSES

Maggots for treatment of wounds in horses.—Blowfly maggots have been used with encouraging results by the Mississippi Station in the treatment of horses for fistulous withers, poll-evil, and similar troubles, and wounds and injuries of various kinds. Progress is reported by the station in the development of methods of rearing maggots for such purposes.

Infectious encephalomyelitis in horses.—Outbreaks of this disease have occurred in horses in different parts of the country during recent years. Mortality is high and animals surviving an attack usually suffer permanent disability such as lack of endurance, blindness, and other troubles. The Nevada Station, which has been studying the disease for a number of years, has developed

a curative serum which has been used extensively and successfully in outbreaks of the disease. This serum has not been used successfully in immunizing animals against the disease. The station, however, has prepared a vaccine which appears to have immunizing value when injected subcutaneously in healthy horses. A preventive and curative serum is being developed by the California Station. Preliminary observations by the Utah Station on carriers of the disease tend to confirm the findings of other investigators that it is transmitted by certain mosquitoes.

CATTLE

Mastitis.—Among the many diseases and disorders of cattle which the experiment stations have studied, particular attention has been given to mastitis. Studies of this disease have been reported recently by the Connecticut (Storrs), Idaho, New York (Cornell), and New York State Stations, among others.

Diagnostic tests for the disease have received particular attention by the Connecticut (Storrs), Idaho, New York (Cornell), and New York State Stations. The New York (Cornell) Station has made an elaborate study of diagnosis and control and has defined the dependable symptoms of the disease and the organisms responsible for it. The New York State Station recommends the strip-cup method as well as the bromthymol-blue test as simple means of testing cows for mastitis. The Idaho Station has found that all present methods of treatment of the disease merely relieve clinical symptoms, such as swelling, and do not destroy the streptococci which cause the disease.

Mastitis may cause soft curds to such an extent, the Idaho Station finds, as to vitiate attempts to differentiate cows giving soft-curd milk.

Infectious abortion (Brucellosis).—Infectious abortion continues to claim much attention by experiment stations and the Department of Agriculture. It is still, however, a major hazard and handicap of dairy production and is to an increasing extent becoming a menace to human health. The Arizona Station estimates that infectious abortion is costing Arizona dairymen $1,500,000 annually. The Illinois Station finds abortion-free cows to be 17 percent more efficient for milk production than those affected with the disease. The possibility of preventing the spread of the disease by strict segregation of reacting and nonreacting animals has been demonstrated by a number of experiment stations and apparently this can be done by relatively simple means. For example, the Arizona Station found that in some cases only a double fence with a space of a few feet between, separating the reacting from the nonreacting cows, was sufficient to prevent spread of the disease. The North Carolina Station warns, however, that segregation of reactors must be complete. Carelessness on the part of caretakers is stated to be responsible for many cases of reinfection of the negative herd. With ordinary purebreds and grades it is considered best to slaughter immediately. The West Virginia Station has been able to eradicate abortion from the station herd by frequent testing, elimination of reactors, and careful herd management.

Infectious abortion and undulant fever.—The relation of infectious abortion in cattle to undulant fever in man has been investigated by a number of experiment stations, including particularly those of Illinois, Michigan, Virginia, and others. From an exhaustive study of the subject, particularly from the standpoint of public health, the Michigan Station has been able to recommend protective measures against undulant fever caused by abortion infection and has published reliable tests for the disease. (See also pp. 87, 97.)

Reducing mortality of range calves.—The California Station has shown that the high mortality of range calves, especially during a dry season, is due in large measure to deficiency of vitamin A in the feed, and has suggested various supplemental feeds which appear to correct the trouble. It has shown that the use of even a limited amount of irrigated pasture as a change from strictly dry feed may result in a larger and better calf crop and may mean the difference between profit and loss. It has also demonstrated other means of supplying the deficiency and reducing mortality.

Disorders due to phosphorus deficiency in feeds.—Roughages and other feeds grown in certain regions have frequently been found to be deficient in phosphorus and their use attended with various disorders. The Kansas Station finds that cattle fed roughages deficient in phosphorus show loss of appetite, poor utilization of the nutrients of the feed, and other disturbances of function. In experiments reported by the station, cattle showing typical effects of phosphorus deficiency in feed responded readily and with marked benefit to phosphorus-containing supplements, such as bone meal. (See also p. 26.)

SHEEP

Foot rot in sheep.—Foot rot of sheep is sometimes the cause of serious losses in sheep on certain ranges and is difficult to control because of the large number of sheep involved. The Montana Station has found that healthy sheep regularly developed foot rot when placed in heavily infected wet pastures. Open corrals on well-drained land, if the soil is allowed to dry, soon lose their infectivity. In a well-drained, irrigated pasture infection did not survive the cold winter conditions of Montana. A saturated (30-percent) copper sulphate solution applied by standing the sheep in a shallow trough containing the solution was found to be of value in treatment of the disease.

Stiff lambs.—Investigations by the New York (Cornell) Station indicated that the primary causal factor in stiff-lamb disease is to be found in the feed given the pregnant ewes. Stiff lambs were produced by ewes fed a ration of oats, barley, cull beans, and second-cutting alfalfa. No stiff lambs were produced by ewes which were liberally or moderately fed a ration of oats, wheat bran, corn silage, and mixed hay. Neither lack of exercise nor heavy feeding of concentrates appeared to be a chief causal factor.

Sheep-scab control.—The Texas Station, cooperating with the Department of Agriculture, has shown that the mite causing sheep scab, a serious and widespread disease, " can be destroyed and scabies completely eliminated by thoroughly dipping the sheep twice, 10 days apart, in an aqueous nicotine-sulphate solution containing at least

0.07 percent of nicotine or a lime-sulphur solution containing at least 0.18 percent of polysulphides." Finely divided sulphur in suspension, sodium fluoride, sodium silicofluoride, and commercial extract of derris root also appeared to be of value when two or more dippings were used. The station warns against the use of arsenical cattle dip for this purpose, because in the strength which must be used to kill the mites the dip may prove poisonous to sheep.

Vaccine for sore mouth of sheep.—A vaccine perfected by the Texas Station for the prevention of sore mouth in sheep is showing a high degree of effectiveness in practical use. Of 31,872 vaccinated lambs, only 2 developed sore mouth and these only in a mild form, while 1,616 out of a total of 19,980 nonvaccinated lambs had the disease in a severe form. The cost of the vaccine was 1 cent a dose.

Chronic copper poisoning in sheep.—The Texas Station has found that the continuous feeding of salt mixtures containing as much as 10 percent of copper sulphate to sheep will induce chronic copper poisoning, often resulting in death of the animal. As a result of this finding, ranchmen have discontinued such use of medicated salt licks containing copper sulphate. Copper sulphate is useful for the treatment of stomach worms in sheep when used in proper amounts, but the continuous feeding of it to sheep may, as the station has shown, be followed by serious consequences.

SWINE

Anemia in suckling pigs.—Anemia is the cause of considerable losses of suckling pigs under present methods of swine management. It is of less importance in cattle, sheep, and poultry. The Illinois Station finds that it is more prevalent in February and March pigs than in those farrowed later. Brushing the udders of sows with a dilute water solution of iron, copper, and sirup, iron and sirup, or iron alone, one or more times daily from farrowing to weaning completely prevented anemia without subsequent ill effects.

Defective eye development in pigs.—Experiments reported by the Texas Station indicate that vitamin A is essential to normal eye development in pigs. Sows fed rations deficient in this vitamin have repeatedly given birth to pigs which were blind, in some cases having no eyeballs, or showed defective eyesight. The station suggests that these findings may have an important bearing on causes of defective eyesight in general, in other farm animals as well as human beings.

Chenopodium for roundworm in swine.—In further experiments the South Dakota Station found that chenopodium may be used as a forage crop and may thus serve not only to eliminate worms but to reduce grain and supplements required for pork production.

POULTRY

Coccidiosis in poultry.—Coccidiosis, a widespread disease of poultry, has been investigated by many of the experiment stations.

The organisms causing coccidiosis, the Connecticut (Storrs) Station finds, do not survive in the soil for more than 49 days. Infection of the ranges is thus not long held over in the soil. Control of the disease appears, therefore, to be a matter of range rotation with frequent and complete sanitation.

Strict sanitation is recommended by the Oregon Station as the only positive means now known of controlling coccidiosis. Liberal milk feeding for a limited period was found to be beneficial.

As an aid in preventing coccidiosis, the Iowa Station recommends a ration consisting of 40 pounds of dried milk, 20 pounds each of yellow corn meal and ground oats, and 10 pounds of wheat bran.

Egg production of hens which had had coccidiosis was found by the Louisiana Station to be permanently reduced, and the station therefore advises that such hens be sold. The station also found that chicks which survived coccidiosis were retarded in growth 5 to 6 months but eventually attained normal weight.

Vaccine for fowl pox.—White Leghorn pullets vaccinated with pigeon pox vaccine were found by the Rhode Island Station, with one exception, to be resistant to the disease after 2 months. The station concludes, however, that as regards duration of immunity, fowl pox vaccine is more reliable than pigeon pox vaccine. Vaccinated laying pullets began to decline in production 2 to 3 weeks after vaccination with pigeon pox vaccine.

Commercial pigeon vaccine conferred a considerable degree of immunity against fowl pox, in experiments reported by the Utah Station. The pigeon vaccine caused no unfavorable reaction following its use and appeared, therefore, to be adapted to vaccination of birds in production. Chicken vaccine is, however, thought to be preferable when it is necessary to immunize pullets not yet in production, because of the increased duration of immunity which it appears to confer.

Day-old chicks and poults were successfully vaccinated with fowl pox virus vaccine by the Texas Station without any apparent harmful effects and with apparently lasting immunity.

Rhinitis of chickens.—A new respiratory disease of an infectious and contagious nature made its appearance in Rhode Island in 1932. The Rhode Island Station determined the nature of the organism causing the disease and was thus prepared to suggest quarantine measures to control its spread, and to offer an effective treatment, namely, dipping the heads of diseased fowls in a dilute sodium hypochlorite solution.

Pullorum disease.—This disease continues to receive attention by many experiment stations, particularly with reference to prevention and control.

Preventive measures proposed by the Oregon Station for the control of pullorum disease include maintaining as high a moisture content as is consistent with good hatching in the incubator, culling and killing all weak chicks just after hatching, and delaying the feeding of chicks until 60 hours or longer after hatching as opposed to the common practice of feeding the chicks within 24 hours after hatching.

Control of roundworms in chickens.—The use of ground tobacco (*Nicotiana rustica*) containing 5 percent of nicotine, at the rate of 0.4 percent of the ration, was effective in controlling roundworms without retarding growth, in experiments reported by the Pennsylvania Station.

Poisonous plants.—Poisonous pasture and range plants and means of protection against them have been investigated by a number of experiment stations.

A study of all poisonous plants of the State, showing their distribution and relative abundance, has recently been completed by the Ari-

zona Station. The station reports losses of cattle in the limestone area of southern Arizona due to prussic acid poisoning by the following plants commonly grazed by cattle in the district: Catclaw (*Mortonia scabrella*), sprangletop (*Leptochloa dubia*), sumac (*Rhus* spp.), mountain-mahogany (*Cercocarpus* sp.), and acacia (*Acacia* spp.). Two of these plants, mountain-mahogany and acacia, are at times especially high in cyanogenetic compounds and have been known to cause death in cattle. In the fall of the year, at or near frost time, when the range grasses become less palatable and the cattle begin to eat heavily of these plants, death is likely to result.

Crotalaria spectabilis seed has been shown by the Florida Station to be poisonous to chickens, pigs, and cattle. The poisonous alkaloid has been extracted and tested by the station and the name monocrotolin has tentatively been proposed for it.

The range plant, *Hymenoxys lemonii*, is reported by the Nevada Station to be the cause of heavy losses of sheep in that State.

Plants containing selenium have been found by the Wyoming Station and others to be the cause of poisoning of range cattle. Certain plants such as woody aster and various species of *Astragalus*, the station finds, have the ability to absorb this element from soils derived from selenium-bearing shale. Other plants growing in the same area not able to absorb selenium from the soil in the inorganic form, absorb it in the organic form from the decaying leaves of the woody aster and other plants that can take it up from the soil. Some of the plants, especially woody aster, appear to be indicators of selenium, since they have not been found growing extensively on areas in which selenium is not present. Selenium poisoning is being exhaustively studied by the South Dakota Station cooperating with the Department.

BETTERMENT OF THE RURAL HOME

The agricultural experiment stations are working along many lines to improve home as well as agricultural practices. In addition to research dealing directly and specifically with problems of the home, various other investigations having as their primary purpose increased profit for the farm through improvement in the quality of food crops, better methods for their preservation and utilization, and new knowledge of their nutritive value are also of value to the homemaker in making available foods in greater variety and of better quality and higher nutritive value.

Research in animal nutrition is becoming more closely allied with research in human nutrition. Animal nutrition has benefited from research conducted on laboratory animals to solve problems in human nutrition. Similarly, human nutrition is benefiting from present-day investigations on farm animals. Little by little, moreover, the experiment stations are extending research in human nutrition to investigations in which human beings, from nursery-school children to old people, are serving as subjects.

Increasing attention is now being paid in experiment station research to home-management as well as farm-management problems—or problems of the consumer as well as those of the producer. Home-management problems include food-consumption habits, clothing and textile selection, the arrangement of the home for comfort

and convenience, the selection of equipment and working tools to lighten the burdens of the housewife at not too great a cost, and the entire management of the resources of the family in times of plenty and times of want.

From the completed work of the past year along these many lines of research which ultimately benefit the farm home, a few examples will be cited in illustration of the progress which is being made toward the goal of optimal family living.

Practical Sources of Vitamins

The distinction between foods that are rich in a certain vitamin but are used only occasionally, and those that contain relatively small amounts of the vitamin but are used very frequently, should be kept in mind in diet planning, for the richest source of a vitamin is not always the most practical. The availability and cost of a food enter into the consideration of its value as a practical source of vitamins.

Apples as a source of vitamin C.—Orange juice is perhaps the most extensively used source of the antiscorbutic vitamin C, with tomato juice probably ranking second, but a part at least of the vitamin C requirement of both children and adults may be met with many other foods, including a fruit that is generally available in the farm home—the apple.

There is much more variation in the vitamin C content of different varieties of apples than of oranges. The Massachusetts Station has made a study of the relative content of vitamin C in the more common eastern varieties of apples, and has translated the findings into estimates of the number of apples a person would have to eat daily to satisfy the requirement of this vitamin. One small apple daily is thought sufficient of the Baldwin and Northern Spy; 2 of the Winesap, Esopus Spitzenburg, Roxbury Russet, Gravenstein, Ben Davis, or Tompkins King; from 2½ to 3 of the Wealthy, Red Astrachan, Arkansas, Rhode Island Greening, or Cortland; and from 4 to 6 of the Golden Delicious, King David, Tolman Sweet, Delicious, or MacIntosh.

In all the apples studied by the Massachusetts Station the peel was found to be much richer in vitamin C than the flesh, and the raw apple richer than the cooked. The Washington Station, like the Massachusetts Station, has found the Delicious apple to be relatively low in vitamin C but nevertheless recommends it as a practical source of this vitamin because it is a relatively large apple and is usually eaten raw and unpeeled. Preservation in cold storage at a temperature as near 32° F. as possible is recommended by the station as a satisfactory means of preserving the vitamin C content of this variety. Higher storage temperatures were found to bring about considerable destruction of the vitamin.

Eggs as a source of vitamins A and D.—Eggs are usually considered an important source of vitamin A (p. 67). The New Jersey Station has pointed out that compared with certain other foods, eggs are not outstanding as a source of vitamin A but are important chiefly because they form such a common article of diet that they furnish a continuous though small supply of this vitamin. From determinations of the vitamin A content of eggs produced by hens receiving the type of laying ration used in New Jersey, it was estimated by

the station that a serving of two average-sized eggs would furnish only 700 units of vitamin A in comparison with 5,000 units for an ordinary serving of spinach, 2,800 for carrots, 8,000 for liver, 2,500 for sweetpotatoes, and 1,700 for butter. Comparisons such as these are useful for the farm housewife to keep in mind in times of scarcity of eggs or any other farm-produced source of vitamin A.

It has sometimes been claimed that egg yolk contains sufficient vitamin D to protect infants against rickets. The New Jersey Station has also investigated this point and has found that one egg yolk contains only about one-twentieth as much vitamin D as one teaspoonful of cod-liver oil. Commenting upon this the station has pointed out that—

> although the vitamin D value of egs is low, it is higher per serving than that of any other common article of food and the supply in eggs is fairly constant in amount. This small amount and the vitamin D that is probably developed by sunlight upon the exposed parts of the body may meet in large part any requirements of the adult human and of the growing individual, particularly in the later stages of growth.

Wild greens a cheap source of vitamin A.—Green leafy vegetables have come to be known as among the most important of the so-called protective foods because of their high content of minerals and vitamins, particularly vitamin A; but this class of vegetable foods usually calls to mind spinach and kale and other cultivated greens. It has been shown by the Kansas Station that such common plants as the dandelion, dock, and lambsquarters, available in many rural sections of the country to all who will take time to gather and prepare them, are excellent sources of vitamin A. The leaves of the dandelion and the dock were found to contain practically as much vitamin A as escarole, considered to be one of the richest plant sources of this vitamin. The leaves of the lambsquarters, although not quite so rich, compared favorably with the cultivated greens that have been studied. A useful guide to the selection of wild greens was published during the year by the Utah Station. This contains illustrations, botanical descriptions, and methods of preparation of 14 of the more commonly used wild greens.

Guava juice as an antiscorbutic for babies.—While the substitution of guava juice for orange juice as an antiscorbutic would scarcely be practical in the States, it has been tested with success in baby clinics in Hawaii. This demonstration was the outcome of the discovery by the Hawaii Station that guavas appeared to be an even better source of vitamin C than oranges, and that the juice extracted as for jelly making, canned, and stored in a dark place for use as needed was as potent in vitamin C as fresh orange juice. The 10 babies taking part in the demonstration were completely protected from scurvy by the guava juice in doses starting with one-half teaspoonful a day at from 4 to 8 eight weeks of age and increasing gradually to 2 tablespoonfuls by the fifth or sixth month.

Potatoes a variable source of vitamin C.—Potatoes were recognized as a practical antiscorbutic long before the existence of vitamins was known, but tests of their vitamin C content have given conflicting results. The importance of potatoes as a leading vegetable crop led several northwestern stations to undertake studies of the vitamin C content of the most common varieties grown in these States as affected by cultural conditions, maturity, and storage.

The Idaho Burkank potato, commonly known as the Netted Gem, was found by the Idaho Station to have a relatively high vitamin C content in the young immature state but to be less potent when mature and dormant, and still less after storage for several months. On the basis of these findings the station recommends that—

if the Netted Gem potato is to be depended upon to supply the vitamin C needed in the diet as may be necessary in certain emergency cases, it should be used in the immature stage or when cell activity has just begun and should be used in generous amounts in the diet.

If dormant potatoes or those of late storage condition are used, increasing amounts should be consumed.

No significant difference was found by the Wyoming Station between potatoes of the Bliss Triumph variety grown on irrigated or dry land, either in the content of vitamin C at the time of harvest or the rate of deterioration on storage. In the opinion of the station, potatoes alone, if used fairly generously in the diet, will be adequate to protect against scurvy in the fall and the first half of the winter. However, in the late winter and early spring there is a decided loss of the antiscorbutic property, so that it is not safe at this time of year to depend on potatoes alone for this health protection. The practical conclusion is that in the late winter and spring potatoes must be supplemented by tomatoes, cabbage, or onions, which are rather cheap on most farms, or by some other source of vitamin C purchased outside, if full health is to be insured. The importance of this knowledge was demonstrated by a survey made in connection with the emergency relief work in the State, which showed that in a considerable number of farm families the only vegetable in the diet in the winter and early spring is potatoes.

Sweetpotatoes for vitamin A.—In some parts of the country sweetpotatoes are as practical a source of vitamin A as potatoes are of vitamin C, on account of the extent to which they are used in the diet. In a study by the South Carolina Station of weekly food records of over 150 farm families, it was found that in certain seasons of the year the consumption of sweetpotatoes in liberal amounts was responsible for meeting the vitamin A requirements. Studies at the Iowa and Tennessee Stations have shown rather wide differences in the content of vitamin A in different varieties of sweetpotato. An even more important finding of the Tennessee Station was that the vitamin A content of the sweetpotato actually increases after digging, the highest values being reached after storage under favorable conditions for 2 or 3 months. No significant differences were found by the Iowa Station in the vitamin A content of sweetpotatoes of a single variety, the Prolific, grown on soil with varying known fertilizer treatments.

Canned tomatoes a reliable source of vitamin A.—Canned tomatoes are universally recognized as a practical, inexpensive source of vitamin C but have been featured very little for vitamin A. In studies by the Iowa Station, newly canned tomatoes were found to give better results as a source of vitamin A than the same tomatoes fed raw. This was explained as probably being due to a greater uniformity in the material tested rather than to any increase in vitamin A content brought about by canning. Tomatoes from a lot canned in 1931 were found to have the same vitamin A content in 1932,

1933, and 1934, showing that canned tomatoes are a very stable source of vitamin A.

Canned strained vegetables as sources of vitamins.—The advent of canned strained vegetables for infant and child feeding has raised the question of their potency in the vitamins they are known to contain in the raw state. The vitamin A content of a number of canned strained vegetables of a single brand was found by the Michigan Station to compare favorably with published values for the same vegetables, raw and canned without straining. The station also found that canned strained tomatoes, peas, and carrots contained more vitamin B than vitamin A; green beans and spinach more vitamin G than vitamin B, and beets equal amounts of the two vitamins.

Mineral Content of Foods

The mineral constituents of foods that are usually considered in checking the adequacy of diets are calcium and phosphorus, because of their use in bone and teeth building and in maintaining other tissues in proper condition, and iron, for its use in maintaining the hemoglobin content of the blood and thus preventing anemia. Copper is beginning to be considered because it is now known that copper is essential to iron for hemoglobin building. Sometimes it is necessary to know the iodine content of foods on account of the relation of iodine to the prevention of goiter and other less well-defined disturbances. It is coming to be realized that there may be wide differences in the content of these elements in the same food materials in the natural state when grown under different conditions, or in manufactured products, depending on methods followed. A few illustrations will indicate what the experiment stations are now doing and at the same time suggest the need of much more extensive work along this line.

Variations in the calcium and phosphorus content of vegetables.—A study at the Alabama Station of the calcium and phosphorus content of various field crops grown by the station with 1,000 pounds per acre of complete fertilizer, and of leafy green vegetables grown on acid soil low in calcium but receiving varying amounts of superphosphate, revealed wide differences in the amounts of calcium and phosphorus in a given vegetable. In general, the calcium content was low and the phosphorus high, as compared with standard values, but lettuce, mustard, and potatoes were low in phosphorus as well as calcium, and onions and peppers relatively high in calcium. The calcium and phosphorus also showed a tendency to vary inversely. The plants grown with increased amounts of superphosphate showed regular increases in phosphorus but only small changes in calcium, the extent of variation differing with the vegetables and the soil. Japanese varieties of turnips were consistently lower in calcium than American varieties grown under the same conditions, but with this exception the variations with variety or age were not significant. This study shows that it is not safe to depend on average values if it seems necessary to calculate with any degree of accuracy the calcium and phosphorus content of diets.

Iodine in potatoes.—Potatoes grown in different parts of Pennsylvania were found by the station to contain iodine in amounts varying from 10 to 216 parts per billion. No correlation was found between

the iodine content of the potatoes and the kind of fertilizer, size of individual potatoes, or variety. Potatoes grown on so-called marine soil had a much higher iodine content than those grown on any of the other soils examined, and those grown on glacial soils contained slightly more iodine than those grown on similar nonglaciated soils.

Sorgo and sugarcane sirups cheap sources of iron.—Sorgo and sugarcane sirups are used so extensively by rural people in certain parts of the country that it is of considerable importance that the Mississippi Station has found both types of sirup to be good sources of iron in comparison with other foods with an established reputation for high iron content. Of the two sirups prepared in the same way, sorgo sirup is by far the richer source of iron. If the sirups are evaporated in iron pans as is the custom in small-scale production on the farm, their iron content may be greatly increased, as was demonstrated in the Mississippi studies.

New and Improved Food Products

The modern grocery store, whether it be of the "chain" variety or an exclusive specialty shop, displays a bewildering array of packaged and bottled food products in ever-increasing variety. One does not have to seek far, moreover, to find stores in which cold-storage cabinets reveal a variety of ready-to-cook frozen fruits, vegetables, and meats which are most time-saving to the busy housewife. The experiment stations are making many contributions to these food products, some of which are noted on page 45. In addition, new varieties of food crops are being introduced and new ways of utilizing surplus or cull products commercially and in the home are being developed through experiment station research.

New fig products.—Improved methods of utilizing the Magnolia fig are being developed by the Texas station. These include more satisfactory methods for its preservation by sun drying and frozen storage, and new recipes for fig preserves, conserves, and paste. Although these are designed for commercial utilization of the fruit they afford suggestions for home use on a small scale.

"Milkwheato" and "Milkorno."—In an effort to make dried milk available to families of limited income who find it impossible to purchase sufficient quantities of fluid milk to maintain health, the New York (Cornell) Station has developed two products now being distributed under the names "Milkwheato" and "Milkorno" in which wheat and corn have been combined with suitable quantities of dried milk, flavored with salt, and packaged with suggested recipes for cooking in various ways.

Food use of pimientos.—A practical test of the food value of the pimiento, previously shown by the Georgia Station to be exceptionally rich in vitamin A, has been conducted by the station in a children's home, where dried or canned pimientos were added to the customary diet of some of the children for 3 months in amounts averaging 1 tablespoonful of the dried pepper or approximately one-half a canned pepper daily for each child. No cases of nausea or digestive disturbances were observed during the entire period of the experiment. There was some indication of lessened severity of colds in the group receiving the canned pimiento. Attractive ways

of preparing and serving pimientos have been developed by the station.

"Conditioning" popcorn.—Popcorn does not pop well when it is too dry. The New York State Station has found that a moisture content of from 13 to 15 percent is needed for the best results in popping. This means that popcorn stored in heated buildings should be kept in airtight containers. A simple method of treating or "conditioning" popcorn which has become too dry to pop well has been suggested by the station. This consists in adding from 2 to 5 tablespoonfuls of water (depending upon the dryness of the corn) to 2 pounds of the shelled corn in a 2-quart fruit jar, closing the jar tightly (using a rubber), and shaking thoroughly. This treatment is said to restore the corn to good condition in a few days.

Soybeans as food.—Several of the stations have been cooperating with the Department of Agriculture in growing and testing for culinary value, particularly in the green immature state, several varieties of soybeans native to Chosen and Japan. The Georgia Station has recently introduced and tested some Japanese varieties which are considered to be a promising food crop to be grown on land where cotton growing has been abandoned. The station is undertaking to help educate the consumer and popularize the new crop through novel ways of preparing and serving both green and dried beans. The Illinois Station, seeking to expand the market outlet for soybeans, has also issued tested recipes for soybeans and soybean products.

Certain varieties of soybeans have been found by the Hawaii Station to be well suited to use as a food in the green and dry state. The Yellow Biloxi has given good results for this purpose. A study has also been made by the station of the composition of the green immature soybean, both in the raw state and as cooked by the method commonly used in Hawaii, which consists in boiling the beans in the pods in salted water for from 15 to 25 minutes. One of the varieties tested was the Seaweed FPI No. 80483, obtained through the Department of Agriculture from Japan where it is said to be used only in the green state. As compared with other vegetables the green soybeans were found to be relatively high in protein, fat, essential minerals, and vitamins, with the exception of vitamin C. The station is of the opinion that cooked immature green soybeans, which form an important part of the oriental diet, might well be added to the diet of other countries. (See also p. 36.)

Home-prepared sirups, fruit juices, and vinegar.—Methods of utilizing surplus food crops, either on the farm or commercially, are being studied by the stations to an increasing extent.

Surplus and cull sweetpotatoes can be used in the preparation of a sirup of pleasing flavor either alone or as a blend with other sirups by methods developed at the Tennessee Station, which has also developed and published simple methods for the home preparation and bottling of strawberry juice for use as a beverage, and of a strawberry sirup for flavoring purposes. Simple methods of utilizing cull fruits and honey, too dark in color or otherwise unsatisfactory for the table, for the preparation of vinegar for home use or local sale, have recently been published by the California Station. (See also p. 45.)

Spoilage of defrosted vegetables.—Extension of the quick-freezing process of preserving fruits and vegetables has given rise to the problem of how the frozen material can best be handled by the housewife and how long and in what condition such products will keep after being defrosted. The Maryland Station found that spinach, peas, and lima beans, frozen and then defrosted, spoiled after 12 to 24 hours at 22° C. and after 36 to 48 hours at 6° C. Spinach deteriorated most rapidly and peas least rapidly. The fresh vegetables stored at 22° and 6° C. spoiled after 2 to 4 days. Quick-frozen foods, therefore, should be used as soon as possible after purchasing and should always be kept in a cold place until used.

Food Preparation

Cooking qualities of apples.—Apple varieties differ not only in their content of vitamin C as noted on page 75, but also in their cooking qualities. It would be of great help to the housewife to know what varieties of apples are best for cooking in different ways. Several of the stations are making systematic cooking tests of local varieties of apples, together with various chemical tests in the hope of showing what constituents in the apple are responsible for certain cooking properties.

The edible quality of an apple when raw is not a reliable criterion for its quality when cooked, the Minnesota Station finds. The station, as the result of extensive cooking tests, has published lists of Minnesota apple varieties most suitable for sauce, for baking, and for coddling or cooking in sugar sirup. By using this list as a guide the housewife can select the best methods of cooking apples available on the farm, or, when purchasing apples, can buy the variety that should give her the best results with the method of cooking she prefers. Other factors than variety, such as ripeness and keeping quality, also enter into the problem of apple selection for cooking. The New York (Cornell) Station is working toward a solution of this problem by making chemical and cooking tests on a number of varieties of New York State apples several times a year and over a period of several years. Among the differences that are beginning to emerge are the changes in acidity of the apples in storage, which are greater for some varieties than for others, and probably explain the flatness of some apples on prolonged storage.

Egg-white foams.—That the art of cookery can be greatly aided by scientific research is well illustrated by a recently completed investigation at the Colorado Station on the influence of chemical and physical factors on egg-white foams. The factors studied for their influence on foam stability (that quality in egg white which produces lightness in cooked products) included beating time, design of the beater, age of the egg, proportion of thin and thick white, variations in altitude, and addition of other materials such as egg yolk or cream of tartar. The results of this investigation are being applied by the station to the problem of cake baking, starting with angel food. From data thus far obtained, it has been found possible to derive an equation based on the tensile strength of experimental angel-food cake which expresses all possible recipes for any desired altitude up to 15,000 feet. The major value of the method is con-

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sidered by the station to be the demonstration of the fact that there is a method of calculating the correct combination of ingredients for one kind of cake that should be equally applicable to other more complex types.

Baking quality of soft-wheat flours.—The usefulness and market possibilities of Illinois soft-wheat flours have been greatly extended through several years' work of the Illinois Station, demonstrating that soft-wheat flours can be used both for cake and for bread making. Uniformity and fineness in size of the flour particles were found to be of more significance in cake making than the percentage of protein in the flour. The lack of uniformity in the particles of hard-wheat flour and the physical character of the gluten are considered to account to a large extent for the poor cake-making qualities of this type of flour. Adding small amounts of starch to a soft-wheat flour still further improved its cake-making qualities.

Flour from Maryland-grown wheat, representative of soft red winter wheat grown extensively in the eastern United States, has been used successfully by the Maryland Station for making biscuits and certain types of cake. The station has developed and published recipes for cakes, quick breads, and pastries to the making of which such flours are particularly adapted.

Use of lard in cooking.—A subcommittee of the National Cooperative Meat Investigation Committee is helping to coordinate lard studies at various experiment stations and the Department of Agriculture. As a contribution to the general problem the Iowa Station prepared a large number of individual lards and a few composite lards from hogs of known history and special feeding, using the open-kettle method with equal parts of leaf and back fats. These lards were analyzed for their chemical properties and compared with various commercial lards and other shortening agents in cooking tests.

With certain modifications in the conventional technique for cake mixing, the station found that cakes of good texture, volume, and flavor can be made with lard as the sole shortening. Lard from carcasses grading medium hard to hard were found to have the best creaming qualities when used at the right temperature, which varied with the different shortening agents. Eggless cookies made with the lards prepared at the station gave a slightly better range of values in breaking-strength tests than other shortening agents. The lards tested proved less desirable, however, than some of the other fats and oils for doughnut frying, owing to a greater quantity of smoke given off during the cooking process. The Nebraska Station is also investigating the practicability of lard for cake making and the Missouri Station has published a bulletin giving general and basic recipes for the use of lard as a shortening agent for various types of batter and dough.

Meat cookery.—Whether to roast the more tender cuts of meat by searing at a high temperature and then reducing the temperature or by using a constant rather low temperature throughout the entire time is a question that has received much attention in experiment station laboratories participating in a national meat investigations project. The Missouri Station found that the standard (searing) method as applied to beef rib roasts gave in general a more attractive looking roast than one cooked by the constant-temperature

method, but that with lamb and pork the differences between the two methods were not so apparent. The constant-temperature method proved to be the most economical of fuel for beef and lamb but not for pork, and the least wasteful as regards cooking losses for all three. Better results were obtained with the constant low-temperature roasting method than with braising for the less tender cuts of beef animals.

Use of dry skim milk.—Recipes have been developed at the Minnesota Station for the use of dry skim milk both in the reconstituted form as a partial substitute for fluid milk and in the dry form as a means of increasing the nutritive value of various types of cooked foods. As each tablespoonful of dry skim milk will contribute almost one-tenth the daily requirement of energy for an average man at moderate work, almost one-third of the protein requirement, and a little more than one-seventh of the calcium requirement, the addition of a tablespoonful or two of dry skim milk here and there in cooking will do much to increase the food value of the diet. Another advantage is that dry skim milk is quite a concentrated source of vitamin G, the vitamin sometimes described as essential for preserving the characteristics of youth. For other uses of dry skim milk see page 58.

Food Habits and Requirements

Knowledge of food requirements at all ages may be acquired in two ways—indirectly, through observations of the kinds and amounts of food ordinarily consumed by people in presumably good health as well as by those showing signs of malnutrition, and directly, through metabolism or balance studies in which the intake and output of various food constituents are determined in subjects on known diets. Both of these methods are being used in experiment station research having for its aim optimal nutrition of people of all ages.

Infant-feeding practices.—The establishment in most cities of clinics to which mothers may bring their babies for examination and advice has given city babies the advantage over rural babies in some respects. Realizing this, the New York State College of Home Economics has been conducting an informal baby clinic at the college for a number of years and has kept histories of the first 2 years of the lives of the babies brought to the college for advice. Analyses of these records of feeding practices, birth weights and gains in weight, and extent of rickets and other nutritional disturbances have helped in correcting poor practices.

In a survey of infant-feeding practices in villages in 16 counties of New York, made by the New York (Cornell) Station, special attention was given to the extent of breast feeding, reasons for weaning babies early or failing to nurse them, artificial feeding practices, and the use of supplementary foods. No striking differences were apparent between the artificially-fed and breast-fed babies, although it was noted that the artificially-fed babies appeared to require cathartics more often than the breast-fed. The average ages at which different supplementary foods were added to the diet were cereals 7.5 months, fruit juices 8.1, vegetables 9.4, eggs 10, and meat and fish 12 months. Nearly half of the babies had never been given cod-liver oil. There were some indications that the babies who had been given supple-

mentary foods early in life "sat, stood, walked, and cut the first tooth earlier than the babies who did not receive these foods until much later."

Food habits of young children.—Using nursery-school children as subjects, the Michigan and Ohio Stations have been studying over a period of years the food consumption of children of this age group. The data from the two studies were quite uniform as to the percentages of essential food constituents contributed by the diets, and the total calories (energy) and proportion of calories contributed by the various food groups. The average diets in each case were slightly lower than present standards as regards the percentage of total calories furnished by milk, decidedly high in sugar, and rather high in the protein group of eggs and meat. The consumption of fruits and vegetables by both groups corresponded closely with the standards, while in the more extensive but less quantitative studies conducted by the Texas and Utah Stations on less selected groups of somewhat older children, as noted below, the consumption of fruits and vegetables was thought to be inadequate.

Iron requirements of young children.—There is considerable question as to the amount of iron needed by children of preschool age. For this reason the diets of nine of the children in the Ohio study noted above were analyzed for their iron content during 2 seasons of 2 consecutive years. The average values were somewhat lower than present standards which, however, allow a considerable margin over what is thought to be the minimum requirement. It is of interest in view of the findings of the Wisconsin Station relative to availability of iron from various sources that about 22 percent of the calculated iron in the food consumed by the Ohio children came from milk, about 15 percent from cereals, 41 percent from fruits and vegetables, and 21 percent from meats and eggs.

Food habits of school children.—From records kept by the children themselves of all food eaten for a week in the spring and another in the winter by about 1,000 white, 500 Negro, and 150 Mexican children, the Texas Station was able to compare the food habits of children of the three groups as well as to estimate the adequacy of the diets. The outstanding feature in the comparisons was the striking similarity between the diets in different seasons, in different sections of the State, and for the three groups. The slight differences noted between the groups were in favor of the white children, next came the Mexican, and lowest stood the Negroes. All of the diets were considered to be somewhat deficient in milk, fruits, and whole cereals, and relatively overabundant in refined cereal foods.

Dental records obtained by the Texas Station of the children in the above study and in another one concerned with the growth in height and weight of San Antonio school children, were analyzed with reference to race, sex, age, and diet, and showed that approximately 70 percent of the white children, 65 of the Mexican, and only 45 of the Negro children had defective teeth. The number of decayed teeth per child was also greater among white children than among either Mexican or Negro children. In the former study the girls had slightly better diets than the boys, and yet in each case slightly more girls than boys in all of the three groups had decayed teeth.

The food habits of rural school children in Utah were studied by the Utah Station by methods similar to those used by the Texas

Station and found to be similar to those reported from other States. The average diet was considered to be adequate in fuel value, but of doubtful adequacy in vitamins and mineral content because of the scant use of vegetables, fruits, and whole-grain products. Both boys and girls were below average weight for age and height and there was a high incidence of dental caries.

Supplementary lunches for school children.—Pasteurized milk, evaporated milk, a tomato concentrate, and a mixture of evaporated milk and tomato concentrate were used by the Massachusetts Station in an investigation, conducted in two schools in a rural farming community and one in a rural industrial village, of the possible beneficial effects of midmorning lunches as far as could be determined by records of school progress, illnesses and absences, height and weight records, and medical and dental examinations. All of the supplementary feedings had some favorable effect upon the general nutritional condition of the majority of the children. Milk alone, either pasteurized or evaporated, was somewhat more effective than tomato juice alone, but the mixture of evaporated milk and tomato juice gave the best results. As judged by medical records, a slight but definite improvement took place in the children receiving milk with but little change in those receiving tomato juice alone. None of the lunches appeared to affect growth in height or incidence of dental caries. There was some evidence of a favorable effect of the lunch on school progress among the children in the lower grades. Improvement was noted in some of the children who were in good condition at the beginning of the experiment as well as in those who were in fair or poor condition. This suggests that such supplementary feedings, while not essential for adequate nutrition for all children, may be of considerable help toward optimal nutrition.

Food selection by college students.—That college students eating all their meals at a cafeteria do not always make a wise selection of food was discovered by the North Dakota Station through observations, including some quantitative measurements, of food selection by men and women students at the college cafeteria. The diets in general were poorly balanced and inadequate. All showed a definite lack of vegetables and fruits and a preponderance of carbohydrate foods, and the women's diets were also decidedly lacking in milk and whole cereals. As regards individual food constituents the diets of the men were below standard in calories and iron and of the women in every food essential. The deficiencies could not be attributed entirely to an effort on the part of the students to economize, for the average costs of the meals based upon 1930 prices were high—amounting to about 81 cents a day for the men and 71 cents for the women.

Using the outputs (amounts excreted) of nitrogen, calcium, and phosphorus of a group of women students on freely chosen diets as an indication of protein, calcium, and phosphorus intakes (amounts ingested), the Kansas Station found the diets to be above standard in calcium and phosphorus and below for protein. The low protein is in line with other recent observations, indicating present tendencies toward lower protein consumption and suggesting that the customary standards are somewhat high for present-day habits of life.

Food consumption and utilization during pregnancy.—In an extensive study of the dietary habits of women during pregnancy and the

efficiency of utilization of the various food essentials, the Oklahoma Station found wide variations in dietary habits of the different women and also great irregularities in the choice of food from time to time by the same women. Nevertheless, the extra needs of pregnancy appeared to be met in almost every respect. All but one of the women studied stored iron, showing that it is possible on a well-selected diet to provide for the extra iron needs of pregnancy without depleting the body's reserves. Nitrogen (protein) was stored by all of the women, although varying widely in amount. Tendencies to high storage of nitrogen in the body were shown by women whose diets contained unusually liberal amounts of milk, meat, and eggs, and extra vitamin B. There was high storage of the essential mineral elements, calcium, magnesium, and phosphorus, in all cases. The ability of these women to store calcium is of particular interest inasmuch as the demands of pregnancy are usually thought to make a decided drain on the calcium reserves in the bones and teeth. It would seem to be entirely practicable by proper diet selection to provide against harmful depletion of the calcium reserves.

Utilization of Food Essentials

Food analyses do not tell the whole story about the value of any particular food in the diet. This can be demonstrated by metabolism experiments, such as those of the Oklahoma Station noted above, by chemical digestion experiments outside the body, and by experiments with small animals. The studies noted below have been selected as illustrations of some of the ways in which the intricate problem of food utilization is being studied.

Digestibility of crust and crumb of bread.—Children used to be made to eat the crusts of their bread. Even babies were fed the crust in preference to the crumb. However, artificial digestion experiments by the University of California have indicated that the protein of bread crumbs is more easily digested than that of bread crust. As babies and young children require a high-protein diet of easy digestibility it might be advisable to reverse the old-time practice and feed the crumbs rather than the crust of bread.

Utilization of meat protein.—The popular impression that meat is less well utilized by persons in middle or old age than by growing children would seem to be justified by the results of studies by the University of California with growing and adult rats to determine the effect of heat upon the nutritive value of meat protein. These studies showed not only that with both growing and adult rats the utilization of the meat protein decreased with the degree of heating but also that the meat proteins compared favorably with milk and cereal proteins for growth in the young rats but were less well utilized by adult rats.

Nutritive value of the proteins in cheese.—The rennet curd of cows' milk is the foundation protein in all types of cheese, but during the ripening process, which is not the same for the different varieties of cheese such as Cheddar, Roquefort, Swiss, and Limburger, unlike changes take place in the proteins, according to experiments by the Illinois Station with rats. The most unusual finding in these studies was that although the digestibility of the protein of the curd was lowered appreciably by all the ripening processes, the capacity of

the cheese proteins to promote gains in weight was not lowered, but in the case of the Swiss cheese at least, was definitely increased. The utilization of the protein was about the same for the Swiss cheese and the rennet curd. Differences in weight gains were shown to be due to differences in the composition of the weight increases—the gains on the cheese protein containing less protein and more fat than those on the rennet protein. The observation that equal gains in weight may differ appreciably in composition shows how complicated is the problem of food utilization.

Raw v. cooked egg white.—It used to be thought that raw eggs were more easily digested than cooked, but recent investigations indicate that the opposite may be true, at least that there is a possibility that raw eggs, if taken in too large quantities, may produce a skin disturbance and other unfavorable symptoms. Recent reports from the Wisconsin and Alabama Stations, corroborating earlier findings, indicate how the skin disturbances and malnutrition caused by raw egg white may be prevented or cured. Brewer's yeast and dried liver were found by the Alabama Station to be effective for this purpose. The Wisconsin Station found cooked pork kidney to be the most effective of various materials studied. For a given amount of the dried egg white, one-sixth as much by weight of the dried cooked kidney and from 1 to 3 times as much of wheat germ or dried egg yolk were required. This means that if human beings are as susceptible as rats to egg white, the margin of safety is not very great if raw or undercooked eggs are used to any great extent.

Food value of raw v. pasteurized milk.—It was noted in a previous report [2] that the Wisconsin Station had found milk mineralized by the addition of suitable amounts of iron, copper, and manganese to be a complete food for experimental rats. This being the case, a comparison of the growth behavior of rats on mineralized raw milk and mineralized pasteurized milk might be expected to reveal even very slight differences in nutritive value between raw and pasteurized milk. Results of such a comparison by the Wisconsin Station indicated that pasteurization has practically no destructive effect upon the food value of a milk of high nutritive quality (summer milk) but may further decrease the value of a milk of lower nutritive quality (winter milk). The feed of the cow was found to have a greater effect than pasteurization on the nutritive quality of the milk. It thus appears that pasteurization not only furnishes a safeguard against milk-borne diseases, such for example as undulant fever resulting from abortion infection, which, according to the Michigan Station, is becoming a serious public-health problem (p. 71), but does not impair the nutritive quality of originally good milk.

Availability of iron and copper in different foods.—Following close upon the discovery by the Wisconsin Station that copper is essential to iron for hemoglobin formation, necessary in prevention of nutritional anemia, there came a reversal of the earlier belief that organic iron can be utilized better than inorganic. The Wisconsin Station, continuing its investigation of the problem of iron and copper utilization,[3] found not only that inorganic iron is more readily available

[2] JARDINE, J. T., and BEAL, W. H. SUPPLEMENTING THE MINERALS OF MILK. U. S. Dept. Agr., Rept. Agr. Expt. Stas. 1933: 54–55. 1934.
[3] JARDINE, J. T., and BEAL, W. H. See footnote 2.

for blood formation than organic iron but also that certain iron salts are more effective than others, and certain natural foods more effective than others when fed in amounts furnishing the same quantity of iron. This showed that the value of various foods as sources of iron cannot be based entirely on their iron content.

Egg yolk, in spite of its high content of iron and copper, has been shown by the Wisconsin Station to be not particularly good for hemoglobin formation. The station attributes this to the relative unavailability of the copper. From the standpoint of diet planning, perhaps the most practical lesson to be drawn from these investigations of the Wisconsin Station is that until more is known about the availability of iron and copper in different foods, safety lies in reliance upon a variety of foods rather than too great dependence upon a single food for meeting the requirements for iron and copper.

Utilization of vitamin A.—The indispensability of vitamin A for normal nutrition is recognized universally. Not only is it necessary for growth and well-being at all ages but there is increasing evidence that even a slight deficiency in some way diminishes the vitality of the body and its resistance to disease. It is evident that every precaution should be taken in diet planning to provide an abundance of foods rich in vitamin A and to safeguard as far as possible any losses.

It has been suspected for some time that mineral oil, used so extensively as a laxative, interferes with the utilization of vitamin A. Recent studies by the Pennsylvania Station, however, indicate that this is not strictly true. Mineral oil does not interfere with the absorption of real vitamin A but only with that of carotene, the yellow vitamin A "precursor" as it is called, if they happen to be together in the digestive tract. The carotene dissolves more readily in the mineral oil than in the intestinal juices and is eliminated with the mineral oil. The real vitamin A, on the other hand, seems to be more soluble in the intestinal juices than in mineral oil and is thus separated from the oil and absorbed by the blood.

In a study of the absorption and storage of vitamin A in the bodies of rats under varying conditions, the Wisconsin Station found, among other things, that about 95 percent of the rat's store of vitamin A is in the liver. If additional vitamin A is consumed it is absorbed very rapidly in amounts proportional to the amounts taken, but only to the extent of about 10 or 20 percent of that in the food consumed. If the body reserves are already low it is more difficult to store vitamin A than in the normal body. The new-born animal has a very small store of vitamin A. This can be increased slightly by increasing the vitamin A in the food of the mothers during pregnancy and to a very great extent by a similar increase during lactation. All this emphasizes the importance of an abundance of vitamin A in the diet at all times, and particularly during pregnancy and lactation, and indicates that it is possible by proper feed to increase the reserve of vitamin A in the animal body. It is suggested that the findings may have a practical application in feeding large animals as well as in human nutrition.

Vitamin B deficiency and utilization.—Definite changes in the nervous system have been observed by the Alabama Station in rats on diets deficient in vitamin B. One of the areas most consistently affected was that concerned with the transmission of taste impulses

to the tongue. This is of particular interest because loss of appetite is probably the earliest symptom of vitamin B deficiency which can be recognized in experimental animals. Loss of appetite is accompanied or soon followed by loss of muscular tone throughout the entire digestive tract, a condition which is responsible directly or indirectly for many ills. The Pennsylvania Station has shown that rats not only fail to grow well on diets deficient in vitamin B, but also that the slight gains made are of abnormal composition. Gastric ulcers have been observed by the Arkansas Station in rats receiving insufficient vitamin B, suggesting the possibility of some connection between a deficiency of this vitamin and gastric ulcers in human beings.

With diets of varying composition different amounts of vitamin B appear to be required. This was noted some years ago by the California Station, which found that with diets rich in fat much less vitamin B was required.[4] Further studies by this station of the "sparing action" of fat for vitamin B have shown that for fat to exert its greatest sparing action both the protein and the vitamin G content of the diet must be high. Fats were also found by the station to differ among themselves in this property, most of the solid food fats such as lard and butterfat being more effective than such edible oils as corn oil and olive oil.

All of these findings emphasize the importance of providing plenty of vitamin B in the diet, as can be done by using some whole-grain cereals and an abundance of fruits and vegetables.

Harmful effects of fluorine.—General interest in fluorine as a harmful factor to be reckoned with in nutrition was awakened by the discovery by the Arizona Station, as noted in a previous report,[5] that the disfigurement of teeth known as mottled enamel is caused by the regular consumption of water containing fluorine in amounts as low as 1 p. p. m. The use of iron salts to remove fluorine from water is being investigated by the station. This work is of vital interest to the inhabitants not only of Arizona but of all other sections of the United States where municipal water supplies are too high in fluorine.

The increasing use of fluorine compounds in spray materials for fruits and vegetables has raised the question of the possible danger from fluorine in other sources than water. The Wisconsin and Arizona Stations have demonstrated with rats that fluorine in amounts considerably above the lowest level for tooth damage but still relatively small causes stunting of growth, a decrease in the retention of calcium and phosphorus, and interference with the normal processes of reproduction. Certain compounds of fluorine were found to be much more toxic than others in this respect. The Arizona Station found that it required 10 times as much fluorine in the form of cryolite and 20 times as much in the form of calcium fluoride as of sodium fluoride to cause slight retardation of growth. When it comes to tooth damage, however, the very small amounts of fluorine required to produce the earliest symptoms were found to be the same for all of the compounds of fluorine tested.

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[4] SMITH, S. L. VITAMIN RESEARCH. U. S. Dept. Agr., Rept. Agr. Expt. Stas. 1931: 80–81. 1932.

[5] SMITH, S. L. MOTTLED ENAMEL. p. 79 of reference cited in footnote 4.

The possible danger to the teeth involved in the consumption of fruits and vegetables which have been sprayed with fluorine compounds has been noted by the Arizona Station, which states that—

> unless steps are taken to control the use of these compounds or to insure their subsequent removal from the food material, mottled enamel will be more widespread and will no longer be only a sectional problem.

The housewife can in a measure safeguard against this danger by washing thoroughly all vegetables and fruits which enter into the family diet.

Vitamin Therapy

The discovery that vitamin A increases general resistance to infections by keeping the membranes of the respiratory and digestive tracts in a healthy condition, and that vitamin D is a good substitute in winter months for sunshine in helping the body to make the best use of calcium and phosphorus, has made the use of concentrated preparations of these vitamins very popular, not only in infant feeding as a substitute for cod-liver oil, but also for children and adults as a general protective measure. The widespread and sometimes indiscriminate use of such concentrates has led many to question their efficacy and safety. Vitamins B and C will undoubtedly be available shortly with corresponding questions concerning the advisability of using them in addition to or as a substitute for food sources.

Vitamin A and the common cold.—Vitamin A concentrates are being advertised and used as preventives of the common cold. To obtain practical information on their efficacy for this purpose the West Virginia Station secured the cooperation of a large group of students at the University of West Virginia in testing throughout the winter months the effect of various preparations upon the number and severity of colds during the period. The preparations used were tablets containing no vitamins, cod-liver oil, halibut-liver oil in capsules, and a cod-liver oil concentrate in tablet form. All three of the vitamin-containing materials were given in amounts calculated to furnish the same concentration of vitamin A. The students were practically unanimous in reporting subjective improvement in the form of increased appetite, weight, or endurance, or relief from skin eruptions or from sinus trouble, as well as in the reduction in the number and duration of colds. The station is of the opinion that these changes can probably be attributed to the improved nutrition resulting from an abundance of vitamin A and possibly from vitamin D as well, and feels that this improved nutrition is worth while in itself, whatever may be the final conclusion with reference to vitamin therapy against the common cold.

Viosterol and parathyroid extract therapy.—The harmful effects of massive doses of viosterol (pure vitamin D) on experimental animals have been demonstrated in many laboratories, but the doses used in most cases have been very much larger than would ever be taken by even the most enthusiastic advocate of vitamin D therapy. The more practical question is the possible danger from moderate overdosage, particularly if combined with parathyroid extract, sometimes prescribed by physicians as another therapeutic agent for disturbed calcium metabolism. Studies planned to answer this question were carried out on rats at the University of California

with the conclusion that although slight overdosage with viosterol alone is without harmful effects, a combination of viosterol and parathyroid extract, both in comparatively low dosage, is as active as a massive dose of viosterol alone, causing deposits of calcium and phosphorus in the kidneys with resulting renal failure. In the opinion of the investigators, "attention might well be paid to this possibility in the clinical use of both parathyroid extract and viosterol."

Food Economics

Dietary studies of the survey type noted on page 83 are useful in showing whether or not food habits are meeting recognized standards of adequacy, but they need to be supplemented by records of actual amounts and the money value of food furnished by the farm and purchased for the family diet, checked against accepted standards such as those published by the Department of Agriculture.[6] Such a study is noted below.

Food consumption of farm families in South Carolina.—Records of the quantity, quality, and money value of all foods used during a single week in two seasons were obtained by the South Carolina Station from about 100 white families and 50 Negro families in the Piedmont section of South Carolina. The records, which were fairly well distributed through the year in order to counteract seasonal differences, showed that approximately 50 percent of the white dietaries and 25 percent of the Negro dietaries could be classified as adequate in all respects. The money values of these dietaries were 24 and 20 cents per capita per day, respectively, while the averages for all of the dietaries were 21.6 and 15.2 cents per capita per day, respectively. The difference in cost of the adequate and inadequate dietaries was largely due to a greater use of cereals, with a corresponding decrease in the protective foods—milk, fruits, and vegetables—in the less adequate and cheaper diets. For both white and Negro families the money value of the home-grown foods decreased from the adequate to inadequate dietaries. This means that although the money value of the adequate diets was higher than that of the inadequate, the actual cost to the families concerned may have been no higher and perhaps even lower because of the greater amount and variety of foods furnished by the farm.

The proportions of the various food essentials furnished by different foods shifted with the season and with the money value of the diets. Milk furnished 61 percent of the total calcium in December and 82 percent in July. Sorgo sirup furnished much of the iron in the lower-cost dietaries, and vegetables, meat, fish, and eggs in the more expensive ones. The sources of vitamin A and vitamin C varied with the season. In June only 18 percent of the vitamin A came from fruits and vegetables, while in the late fall and early winter the liberal use of sweetpotatoes and leafy green vegetables (such as turnip greens and collards) brought the percentage of vitamin A furnished by this group of foods up to from 71 to 79 percent of the total. During the summer fresh fruits and melons provided liberal amounts of vitamin C. In the late summer tomatoes furnished about one-fourth and in the fall and winter green and

[6] Stiebeling, H. K., and Ward, M. M. Diets at four levels of nutritive content and cost. U. S. Dept. Agr. Circ. 296, 59 pp., illus. 1933.

yellow vegetables about two-thirds of this vitamin. Fresh lean meat supplied an increased proportion of the total calories during the winter, particularly in the higher-cost dietaries. At the lower money values protein from animal sources (meat, milk, and eggs) was between one-third and one-half of the total and at the higher values one-half or more of the total. The results of these studies appear to furnish information of practical value in planning rural dietaries, particularly in connection with food production on the farm for family use.

Planning an adequate diet at minimum cost.—Experiment stations and extension services in many States are being called upon for help in diet planning for families in straightened circumstances. In response to such a need the Vermont Station and Extension Service, cooperating with the Vermont Emergency Relief Administration, undertook to study the possibility of adequately feeding six women for 1 week on food purchased for $7, the weekly allowance for food relief for a family of six. The food order was based upon the adequate diet at minimum cost proposed by the Department of Agriculture. All of the meals were carefully planned in advance and nearly all of the food was purchased at the week-end when special prices were available for certain foods. It was found possible to provide an adequate and well-balanced diet for the group on the stated allowance, although it was felt that had the group included men and growing children even more careful planning would have been necessary.

Economics of Clothing and Textiles

It is or should be the desire of every housewife to use as much wisdom in the selection of clothing and household textiles as of foods, but she has been hampered in the past by the lack of definite standards of quantity and cost with relation to family expenditures as a whole and of information concerning the quality of the materials she purchases, whether it be sheets and blankets or dress materials. Considerable progress in overcoming these difficulties has, however, been made by the Department of Agriculture, the experiment stations, and other research agencies during the last 10 years. The two types of investigation are illustrated below.

Clothing expenditures of New York farm families.—The New York (Cornell) Station has reported a study of the cost of clothing purchased by a group of farm families including farm operators, housewives, and children of different ages, and taking into account the amount and kind of home sewing. The station found that the expenditures for clothing ranged from $9 to $690, with an average of $165 a year per family (averaging 3.6 persons dependent on the family income), or about 20 percent of the total cash household expenses. Of the total amount spent for clothing, an average of 30 percent was spent for the housewife and about the same amount for the operator, leaving 40 percent for the other members of the family. However, the proportions spent by different members of the family varied to a marked extent with the composition of the family. Boys and girls in their teens required a relatively large proportion of the clothing budget. The average expenditure per family for household linens for the year was only $12. In general, the families did not seem to plan their expenditures for clothing

(or household linen) by the year, but made purchases as needed and when money was available.

Quality standards for textile fabrics.—Studies in the textile-testing laboratory of Kansas State College showed that certain samples of percale supposed to have been sold under the certification plan developed by the United States Bureau of Standards did not meet the necessary specifications and were of no better quality or appearance than other percales purchased at a lower price without this guarantee. Another study in the same laboratory of the durability of blankets as affected by finish, weight, and tensile strength indicated that the tendency toward light weight, fluffiness, and long nap has resulted in blankets which are very satisfactory as regards warmth and comfort, but the finishing or napping process was found to weaken the blankets in the filling, making them much weaker in one direction than in the other. Of 6 blanket materials tested, only 2 weighing considerably more than the weaker blankets proved strong enough to withstand wear and cleaning for a reasonable period of use. As a rough guide in blanket selection, the station suggests that a 60 by 80 inch woolen blanket should weigh about 2¾ pounds, a 68 by 84 inch blanket at least 3 pounds, and a 72 by 84 inch blanket at least 3⅓ pounds for satisfactory warmth and durability.

Living Expenditures of Farm Families

Changes in living expenditures of Illinois farm families.—Many farm families in Illinois have acquired the habit of keeping household accounts year after year. A study by the Illinois Station of a number of such accounts for the period 1930–32, during which income fell, showed the greatest retrenchment in recreation, then in gifts, then in automobile, savings, education, repairs, and furnishings, church, operating expenses, personal items, health, and least in clothing. The decrease in cost of clothing, however, amounted to 48 percent from 1930 to 1932. Although the cash expenditures for food decreased, food consumption actually increased because of increase in home production of food during the period.

Living expenditures of South Carolina farm families.—Examinations by the South Carolina Station of account-book records kept by a group of South Carolina farm families showed that although the average value of the total living costs was relatively low as compared with those reported by other stations, the percentage of the total supplied by the farm was relatively high. It is significant that about one-fourth of the cash income came from the housewives' earnings from special types of farm and home enterprises.

Household Equipment

Impartial information on the relative cost and efficiency of different types of household equipment, small and large, is the objective of studies by several of the experiment stations.

Factors of economy in cooking with electricity.—Practical information and advice on the most economical use of electricity for cooking is to be found in several recent publications of the Maine Station. These give information on the construction and effective operation of electrical equipment for cooking. On the basis of nearly 1,000 rec-

ords of actual cooking practices by farm women in the State, the station gives the following general suggestions to housewives who have changed or are changing from wood or coal to electricity for cooking:

In order for the Maine housewife to be able to use the electric range at reasonable cost, she should secure other means of heating large quantities of water; make a greater attempt to use the oven more economically than she has been by baking more than one food at a time, and by using the oven for only those processes which cannot be satisfactorily cooked on the surface, or by using a small, low thermal capacity oven for short time processes (if they occur sufficiently often to permit a saving in cost of operation which would make the purchasing of an extra oven a sound investment); utilize the heat stored in the oven and in the surface units by following one group of finished processes immediately with another group while the oven or the surface unit is hot; and time her cooking processes so that foods will not be cooked longer than necessary.

Choosing and operating electric stoves.—Practical advice to prospective purchasers of electric stoves has been furnished by the Nebraska Station following an investigation of the principal types now on the market. The most important features to consider, in the opinion of the station, are quality, working convenience, and cost of operation. The exterior finish should be a high-grade porcelain enamel fused on fairly thick sheet metal. The rim of the oven door should be chromium or nickel plated, not for the appearance of the stove but to help reduce heat losses from the oven. Other means of reducing heat losses from the oven are good insulation, a well-fitting door, and a carefully adjusted thermostat of high quality for automatic heat control.

For surface units the ring and tubular types are recommended by the station as economical to operate and rapid for cooking. For greatest economy the cooking utensils should exactly fit the unit, make good contact with the unit surface, and be just large enough to hold the desired quantity of food.

Electric dish washing.—A hand method, a sink spray method, and an electric dish-washing method were compared by the Washington Station for their effectiveness in washing dishes required for serving a selected breakfast, lunch, and dinner for a family of five. The sink spray method did not prove satisfactory, but with the electric dishwasher the time saved over that required for hand washing amounted to a little over 18 minutes for the three meals. This does not seem a great saving of time, particularly in consideration of the relative money cost of the two methods, which were estimated to amount to $2.95 a month for the electric washer as compared with 45 cents for the supplies needed for washing dishes by hand. From the standpoint of sanitation, however, the electric dishwasher is recommended because much hotter water can be used in it than is customarily used in hand dish washing.

The Farmhouse and Its Arrangement

The Nation-wide farm housing survey financed by the Civil Works Administration and organized and carried out under the direction of the Department of Agriculture has aroused much interest in rural housing needs, including repairs and improvements in existing houses and plans for building new houses and remodeling old ones. The

experiment stations have cooperated in this survey in a number of ways, including the preparation of summaries and analyses of the survey records for individual States, designs for farmhouses suitable for various sections of the country, and plans for interior arrangement. Other experiment station studies undertaken before the newly awakened interest in the farm home resulting from this survey are proving of great assistance in these plans.

Kitchen arrangement.—Arrangement of the kitchen to save time and steps is highly important to the housewife. The Vermont Station has recently reported a study of the subject in farm kitchens and in greater detail in a laboratory kitchen in which it was possible to make more readjustments than in an already occupied kitchen. A rearrangement of one of the farm kitchens with no additional equipment reduced the number of steps taken in preparing, serving, and cleaning up after three meals a day from 2,297 in the old kitchen to 1,445 for the same meals in the rearranged kitchen. In a second farm kitchen, which was entirely remodelled, the number of steps was reduced from 3,215 to 1,034. In the laboratory study an arrangement was finally found which reduced the time required to prepare and serve, and clear away for a simple dinner for five persons from 3 hours 46 minutes 17 seconds to 2 hours 5 minutes 35 seconds, and the number of steps from 1,516 to 131. Plans and charts developed in the course of this study might be used in any home kitchen to determine the most effective arrangement of present equipment and, in some instances, to demonstrate the need of additions or replacements.

Planning a farmhouse for family needs.—Specific suggestions as to kitchen arrangement and equipment with similar plans for the rest of the farmhouse have been offered by the Oregon Station and amplified for publication in mimeograph form by the United States Bureau of Home Economics in connection with the National Farm Housing Survey. These suggestions are concerned chiefly with meeting the needs of the farm family, with little attention to the actual design of the farmhouse. A series of about 20 plans for farmhouses of from 2 to 6 rooms with lists of materials, retail price data, working drawings, and exterior perspectives has been prepared by the Arkansas Station. The designs are based on surveys of housing conditions and needs in the State and are adapted to use of locally available materials. Farmhouse plans were also published during the year by the Texas Station.

RURAL SOCIAL CONDITIONS AND RELATIONS

An increasing interest in rural-life problems is evident in recent work of the experiment stations. This interest has been accentuated by the activities of the Agricultural Adjustment Administration, the Federal Emergency Relief Administration, and similar National and State organizations. The following are a few examples of such work recently reported by the experiment stations. Additional examples will be found in their appropriate connection and application in other parts of this report.

Relation of economic to social conditions.—A combined farm-organization management and sociological study was made by the South Carolina Station simultaneously in each of the major land-use areas

of the State during the year 1933–34. The study included both owners and tenants and white and colored farmers. One phase of the study supplied information on current organization and use of land, soil type and reaction, crop yields, livestock production, contribution of the farm to family living, investment, etc. Another phase dealt with farmer mobility, participation in educational, fraternal, and social organizations, school attainment of operators and their children, and material possessions indicative of economic and social well-being. As a result of this study it is now possible for the first time in South Carolina to correlate farm income with social and economic status and further to show the relationship between mobility among farmers and their material and cultural possessions.

Division of labor and interests in farm families.—Studies by the North Carolina Station of selected farm families have shown that the division of labor is more definite for men than for women. Social participation was limited in all families, but more particularly so in families dominated by the husband. Family members had few common activities beside their work. Families under joint control of husband and wife showed a higher economic and social status than those controlled by husband or wife. There was greater uniformity among the families with reference to practices influenced by economic factors than in social practices where the members could exert more choice.

Lack of cohesion in farm population.—Studies by the Arkansas Station have indicated that the farm population has very little cohesion in either social or economic activities. The results points to the need for definite efforts in the direction of organizing farm men and women in such a way as to raise the standards of their economic and social activities.

Urban-rural migrations.—In a study of urban-rural migrations, the New York (Cornell) Station found that urban-rural migration, or back flow, has been taking place with increasing rapidity during the last decade. This has been made possible largely by the automobile and improved highways and is presenting many problems from the standpoint of social organization and relation in the country.

Excessive moving among farmers.—A significant fact brought out by studies of the South Carolina Station is that excessive moving among farmers is as a rule disastrous to their economic and social well-being. This study indicates that, even among owner farmers—

> those who have moved the most have accumulated the least and have been of least value to their respective communities. There is hardly an exception to the fact that those farmers who have done the best * * * have moved the least.

The main conclusion from a study of movement of rural people in Genesee County, N. Y., by the New York (Cornell) Station, is that underlying the social life of the county—

> is a stable population, centered in its farm-operating families. Upon this population can be built the secure foundation of organized community life, social organizations, and economic cooperation. These families are constituted mainly of native husbands and wives reared on farms in the immediate vicinity of their present homes. Their interests are centered in the farms and communities where they live, and these families furnish the materials for direction into larger social activities.

Decline in rural communities.—Studies reported by the New York (Cornell) Station indicate a distinct decline in small rural centers, especially business centers, and that such centers are more influential socially than economically. The station found that the average rural family patronizes only two other centers besides the local village, and one of these is a city. Within the areas of 500 or more inhabitants, the rural families secure most of their services at the local centers.

Farm versus village living in Utah.—From a study of housing conditions in one community, the Utah Station concludes that—

> Edge-of-town homes are superior to all other homes in the village. Village farm homes are only slightly inferior to edge-of-town homes. While inferior to village farm homes, farm-dweller homes are better than nonfarm homes. Ecological forces in Plain City operating in the field of housing have placed nonfarm homes at the bottom of the heap; just above them are the farm-dweller homes; higher still, with a considerable margin of difference, are the village farm homes; slightly higher yet are the edge-of-town homes. These relative positions are determined by the houses themselves, by improvements of home grounds, and by conveniences within the homes.

Rural health.—Rural health problems are receiving increasing attention by the experiment stations, particularly those which involve transmission of diseases of farm animals to man. For example, a recent publication of the Michigan Station deals extensively and exhaustively with undulant fever (brucellosis) in man as related to infectious abortion in cattle (p. 71). This disease, which is communicable to man from the lower animals, particularly the goat, cow, and pig, by direct or indirect contacts or by ingestion of infective animal material, has spread all over the world and affects persons of all ages and both sexes, regardless of occupation. The station has shown that diagnosis of the disease can be made with reasonable accuracy and has indicated precautionary measures to be taken to avoid the disease. As explained on page 71, the Virginia Station has also studied undulant fever as related to infectious abortion in cattle and as a result has been able to make available to veterinarians and public-health officials information to aid them in dealing intelligently and effectively with control and eradication of the disease as a public-health measure.

Other examples of station work having a very direct and pertinent bearing on human health problems might be cited.

FARM BUSINESS AND FINANCE

Questions of land appraisal and taxation, farm tenancy, use and cost of farm power and implements, farm credit, marketing of farm commodities, and similar matters are leading subjects of investigation by the experiment stations. Interest in such problems has been accentuated by State and national programs of agricultural adjustment. The following are a few examples of such work recently reported by the experiment stations.

Farm accounting.—In a detailed study of accounts kept by 108 dairy farmers in 1933, the Minnesota Station found that labor incomes on these farms range from $588 to $6,438, with an average of $986. The most important factors affecting income were butterfat production per cow, feeding efficiency, number of productive animals per 100 acres, crop yields, selection of crops, labor efficiency, control

of expenses, and size of business. The station's findings are being widely used by extension agents in reorganizing and improving the operating plans of many dairy farms in Minnesota. With the prevailing low incomes due to drought and low prices, measures of strict economy in production are considered vital.

Taxation.—The general property tax was found by the Maine Station to be about three-fourths of the entire tax burden of farmers in that State engaged in apple, blueberry, dairy, potato, and poultry production. There was an upward trend in real-estate taxes in Maine after 1913, namely, an index of 246 in 1932 as compared with 100 in 1913, with a farm-price index of 67 and real-estate values of 109.

The property tax on livestock has tended to increase more rapidly than livestock values when prices of livestock were rising and to decline less rapidly than livestock values when prices of livestock were declining. * * * Many inequalities were found to exist in the assessment of farm property, both real and personal. Very frequently large farms were assessed relatively less than small farms. Similarly, personal property on large farms often was assessed relatively less than on small farms.

The lower taxation of large farms as compared with small is attributed to relatively low assessments and relatively large incomes of the large farms. Under present conditions of taxation in Maine it appears that many towns are too small for maximum efficiency in government, and the station suggests consolidation of the smaller local units.

The average taxes paid on Montana land and buildings was found by the Montana Station to be 51 percent higher in 1933 than in 1913. The increase is attributed largely to increase in expenditures of State and local governments during the same period, which in turn is due largely to the increased construction of public buildings and roads; the increased business activity, boom prices, and doubling of the general price level which accompanied the war; the higher general living standards and the increased use of the automobile following the war; the policy of borrowing followed during prosperity and the loss of public funds through bank failures; the continued use of the general property tax as the main source of revenue; and the predominance of real estate, especially farm real estate, in the property-tax base. The greatest increase in expenditures was for highways and schools.

It has been especially difficult for farmers to pay their taxes during the past few years because of the extremely low level of farm prices and incomes. In 1933 it took nearly twice as much wheat to pay the average tax per acre on Montana farm real estate as it took in 1913, three times as much beef, about twice as much lamb, and about one and a half times as much wool.

Suggested ways of reducing cost of government and taxation are reorganization and reallocation of government functions, curtailment of services, and reduction of salaries.

The major part of the revenues of Nebraska, the Nebraska Station finds, are received from the general property tax, largely from real estate. About 63 percent of the grand assessment roll of the State is farm property. Farm income has been small in recent years, but general property taxes have averaged about 225 percent of prewar. For farms operated by their owners, the farmer paid more than 15 percent of the farm income remaining after deducting all expenses except taxes for the 13 years 1920 to 1932,

inclusive. Data for 352 tenant farms in 1930, 357 tenant farms in 1931, and 520 tenant farms in 1932 indicated that the landowners turned over to the State and local governments 20.6 percent of their net income in 1930, 35.5 percent in 1931, and 61.6 percent in 1932. Many landowners did not have sufficient incomes from their farms in 1932 to pay taxes, insurance, and other necessary expenses.

As a result of further study of taxation in Louisiana, the Louisiana Station secured information to serve as a basis for revising the State and local financial systems and was able to make specific recommendations to this end. This study was undertaken in response to an awakened interest in taxation in the State, demanding reliable information on various features of the subject. A unification of tax administration, now scattered in many State departments, is the principal recommendation made by the station.

A method thought to meet the logical requirements of land classification for purposes of taxation has been worked out by the North Dakota Station cooperating with the Department of Agriculture.

Unusual interest has been shown by State officials in studies by the South Carolina Station of the relation between assessed and actual value of farm real estate. This study aims to relate assessed value to income, farmers' estimates, and expert appraisals, as well as true consideration sales price. It was observed that it was almost invariably the case that the ratio of assessed to sales value decreased with the amount of the sale. In other words, farmers with property valued at less than $3,000 pay taxes which are from 2 to 3 times higher in proportion to those paid by farmers with property valued at $15,000 and above. The results of these studies are being freely used by those interested in a reappraisal of farm real estate and a reorganization of the tax system.

In a study of farm taxation in Texas, supplemented by a study of farm tax delinquencies, farm tax sales, and land transfers, under the Civil Works Administration, the Texas Station found that real property constitutes about 50 percent of the total property and bears most of the taxes, whereas 98 percent of the intangible property escapes direct taxes. Moreover, this study has shown the need for a land-plotting system in every county showing the acreage, ownership, and description of every piece of real estate. The lack of such a plotting system results in a haphazard, inefficient, and costly system of taxation.

Farm tax delinquency.—A complete inventory of all rural lands in the State of Arkansas with reference to tax delinquency, reversion, and State ownership, made by the Arkansas Station, in cooperation with the Department of Agriculture, showed that in addition to the effect of the depression, delinquency and reversion in the State results from poor administration of tax laws and from faulty tax titles. The study furnished a basis for correction of tax evasion through delinquency, which it is thought will greatly improve. A similar study by the Louisiana Station showed tax delinquency to be higher in those parishes where a balanced agriculture was not practiced and where livestock production was not an important part of the farm program. Tax delinquency in tick-free parishes averaged 5.48 percent. In infested parishes it averaged 10.36 percent.

A State-wide farm tax delinquency study initiated by the South Carolina Station during the year showed for the first time the staggering total of unpaid taxes in each county and school district in South Carolina. Over 32,000 South Carolina farmers had not paid their 1928 taxes by March 1, 1929, and more than twice that number were in arrears for 1 or more years on March 1, 1933. During the 5-year period from 1929 to 1933 a total of $8,000,000 in farm real-estate taxes was allowed to go into execution, and of this amount about $5,000,000 was unpaid as of March 1, 1934. These figures do not include delinquencies on personal and corporation property nor on real estate in towns and cities. Analyses show a surprisingly large percentage of delinquents whose annual tax bills amounted to less than $25 and even less than $10. Also, evidence available indicates a considerable number of "repeaters." Both of these things suggest that ability to pay is not the only factor in tax delinquency.

In 15 representative counties of Tennessee 54 percent of the acreage and 42 percent of the taxes on acreage was found by the Tennessee Station to be tax delinquent in 1932. The 5-year average of acreage delinquency, 1928–32, was 25 percent. In three of those counties approximately three-fourths of the acreage was delinquent in 1932.

Because of its familiarity with the source of land and taxation information acquired during previous studies, the Wyoming Station, among others, was able to move quickly in cooperation with the Department of Agriculture in the study of farm real-estate transfers, foreclosures, tax delinquencies, and tax sales set up as one of the national C. W. A. projects.

Farm credit and foreclosures.—Studies by the Arkansas Station of the operation of agricultural-credit corporations in Arkansas have revealed the weaknesses and the services that can be expected from such institutions. As a result of the investigation, recommendations were made for the adoption of local production-credit associations similar in function to the farm-loan associations as provided for in the Federal land bank system. The Federal Government has inaugurated a new production-credit system along practically the same lines as those recommended by the station.

In a study of the use of credit on large owner-operated farms located in different parts of the State, the Kentucky Station found that in 1931 and 1932 debt and interest charges exceeded the cash farm income. Two-fifths of the farms studied were mortgaged. One-third of the farmers did not use credit of any kind in 1929. More of the medium-sized farms were mortgaged than of either the large or small farms. The large farms used more cash credit, while the small farms relied more on merchant credit.

> Cash crops, particularly tobacco, occupied a more important place in the production program of mortgaged farms. Similarly, short-term credit was used on a larger proportion of both mortgaged farms and farms of intensive tobacco production. The use of merchant credit was particularly prevalent and widespread on the latter farms. * * * The owners of mortgaged farms were younger, and had on the average held title to their farms a shorter time than had the owners of nonmortgaged farms.

Information regarding the classification and value of soils published by the Maryland Station has proven very helpful to farmers of that State, but it has been particularly useful to land appraisers in estimating the ability of the land ultimately to pay off a loan.

There have been many farm mortgage foreclosures in the Middle West during the past 10 years, the Nebraska Station finds, but the station states that the foreclosures figures do not present a true picture of conditions. Many have preferred to deed back their farms to the holders of the mortgages instead of being foreclosed. Most token transfers have been in reality forced sales.

Farm tenancy.—As a result of a study of farm tenancy, the Maryland Station suggests modifications of contracts which it is thought will be more equitable to both parties to the contracts but will also stimulate building up of the productive capacity of the soil. It is believed that the present leasing system in the State may be so modified as to encourage improvement of the soil, the farm, and the rural community and give greater incentive for better farming to both the landlord and the tenant.

Cooperative marketing.—In a further study of farmers' cooperative associations in Florida, dealing especially with their organization and management, the Florida Station has found that such associations render a useful service in handling Florida products, especially citrus fruits, truck crops, livestock, and miscellaneous products, and in matters of credit and the like, especially in case of citrus and truck crops. They have also proved helpful especially in the purchase of fertilizers and supplies for their members. In this respect their services were greater in case of truck crops than of citrus crops.

From a study of the operation of six cooperative elevators in western Kansas, the Kansas Station found the chief weaknesses in financial structure and operating policies of the cooperative elevators of the hard winter wheat belt to be small membership, too liberal extension of credit, small margins on the grain handled, and limited volume of business. As a result of the work of the station there has been a marked improvement in the financial condition and operating policies of the elevators of western Kansas. One of the first steps has been the improvement and strengthening of credit policies. Many organizations have adopted a policy of cash or payment in 30 days on sales of side lines. Other methods also have been used to reduce the amount of credit losses. Many of the more successful associations have found it desirable to hold their membership by economical and efficient operation rather than by overbidding the price of grain in an effort to meet competition. Farmers have been benefited by these findings through increased efficiency and reduced operating costs of their elevators. Stockholders have been protected by the establishment of stronger and more stable organizations, and consumers have benefited by the development of more economical methods of marketing grain.

Motor-truck marketing.—Motor-truck marketing is rapidly increasing. For example, the Kentucky Station reports that of the 331,214 head of stock received at Cincinnati in 1930 from Kentucky, 34 percent was delivered by motor truck. Over 67 percent of Kentucky livestock received in the Louisville market was delivered by truck. The advantages to the farmer of livestock transportation to market by truck are summarized by the station as follows: Rapidity, convenience, and cheapness of service; opening up additional market outlets; and opportunity for livestock producers to gain a better understanding of market conditions and requirements. Cost showed considerable variation. Distance apparently does not affect truck

rates to the same extent as competition within an immediate vicinity or road conditions.

Many farmers think that the use of motor trucks could be increased if improvements, such as the following, were made: Better trucking equipment and protection of livestock en route to market, more systematized business methods used by truck operators, better methods of handling livestock en route to market, uniform charging for services, better roads, and abolishment of practice of discriminating against livestock delivery by truck at the terminal markets.

An increasing use of motor trucks in livestock marketing and improvements in methods and equipment for such service, with a decline in cost up to 1932, is reported by the Ohio Station. About 50 percent of farmers included in a study by the Ohio Station of advantages and disadvantages of truck marketing of livestock indicated that they could pay 5 to 10 cents more per hundredweight to market livestock by truck, thus indicating that truck marketing is more desirable than marketing by rail, even if such service costs more.

Use and expense of farm power and implements.—From a study of the experience of a large number of farm operators, the Illinois Station concludes that there is no basis so far as net income is concerned for recommending any one type of power for any large group of Illinois farms.

That many farmers can cut their operating costs without changing their type of power is indicated by the wide variation found in operating costs among farms similar in size and productive organizations and operated with the same type of power. On the other hand, it is doubtless true that many farmers have profited by changing their power organizations and that still others would profit by doing so.

Farm implements were found by the Kentucky Station to represent 4.6 percent of the investment of farms studied by the station. Over 90 different kinds of implements were found in use on 101 farms. The length of service of most of the implements was short, due largely to short seasonal use. Hired labor appeared to increase the annual implement expense. Depreciation represented 47.7 percent of the total annual expense of farm implements, repairs 22.4 percent, interest 17.8, housing 4.6, oil and grease 4.6, insurance 2, and taxes 0.9 percent. Increased annual use reduced the unit expense.

AGRICULTURAL ENGINEERING

There are few farm and farm-home operations into which engineering in some form does not enter. It plays an essential part, as will be seen, in most of the work referred to in previous sections of this report. There are recorded here a few especially significant examples of work in agricultural engineering in some of its broader economic aspects, recently reported by the experiment stations.

Plans for farm structures.—In 1930, according to the United States Census Bureau, the buildings on farms in the United States represented an investment of nearly $13,000,000,000, of which more than $7,000,000,000 was invested in farm dwellings. Such an investment in farm structures has prompted a large number of the stations to undertake extensive studies with the object of lowering the cost and increasing the service and durability of farm structures. Typical of such work is the preparation and distribution by the California Station of working drawings with full descriptions and bills of materials for 20 farmhouse designs suitable for general use in the State, and for almost a hundred dairy structures, feed barns, hog

houses, sheep barns, crop storages, packing sheds, fruit-sulphuring houses, self-feeders, and similar structures. These plans are all for standard construction and are divided into three cost groups, i. e., $750–$1,000, $1,250–$3,000, and $3,000–$6,000.

In connection with the development of structures for special purposes it was possible, for example, to reduce the storage losses of sweetpotatoes in the San Joaquin Valley from an average of 40 percent to less than 10 percent by modifying the storage structures and management methods. Plans have been developed for five different types of milking barns, to meet the diverse conditions of the State, all of which conform to the public-health standards for milk houses and milking barns established by the station in cooperation with the State Department of Agriculture and the California Association of Dairy and Milk Inspectors. The description given of each structure, its use, capacity, cost, and specifications and materials list is such as to enable any farmer to make intelligent changes in the plans necessary to meet his needs more adequately.

Fourteen Middle Western stations have cooperated along similar lines in efforts to lower the cost and increase the usefulness and length of service of farm buildings, and have formulated what is known as the Midwest Farm Buildings Plans Service which operates in the interests of the farmer, the contractor, and the building-materials industry.

The national farm housing survey, led by the Bureaus of Agricultural Engineering and Home Economics of the Department of Agriculture, and participated in by the experiment stations and extension services of 46 States, brought together for the first time the most useful results of research at the stations and by the Department on the planning, design, and construction of farm dwellings. The culmination of this survey was the publication of a farmers' bulletin [7] of the Department of Agriculture, which contains plans selected from those prepared and made a part of the results of the survey by the cooperating institutions. Working drawings of these plans are available from the extension services of the States concerned.

Rammed earth for farm structures.—The stations are constantly searching for cheap, locally obtainable building materials adapted to local climatic conditions and requirements from which durable and serviceable farm buildings may be constructed. Both the South Dakota and California Stations have had considerable success in developing the use of rammed earth for such buildings as poultry houses, ice and crop storages, and small general-purpose barns and animal shelters, and in some instances for farm homes.

The conditions under which rammed earth may be most effectively used for construction of farm buildings has been given special study by the South Dakota Station with the result of showing with a considerable degree of exactness the kind of soils suited to the purpose and the conditions and methods most likely to give satisfactory results. It appears that the soil used should not contain less than 35 percent nor more than 85 percent of sand. The optimum water content was shown to vary from 7 to 16 percent, depending on the

[7] ASHBY, W. FARMHOUSE PLANS. U. S. Dept. Agr. Farmers' Bull. 1738, 70 pp., illus. 1934.

proportion of sand. Seven percent proved to be optimum for a soil containing about 70 percent of sand. Durability and strength were found to be increased by adding lime and fibrous material. Ordinary reinforcing materials were not used with advantage.

Plow design.—Plowing consumes about one-third of the 15 to 18 billion horsepower hours used annually in the United States. Plow design and adaptation have in the past been based largely upon empirical testing, and losses due to wasted power, unsatisfactory performance, and scrapped plowing equipment have been large.

Studies of plow design and action by the Alabama Station have for the first time established certain fundamental principles essential for proper selection, design, and adaptation of plows for different types of soils which reduce the cost of tilling and eliminate expensive testing. From a study of the forces and soil reactions which control the scouring of plow moldboards, the station has developed formulas which make it possible to determine the form of moldboards best suited to different soil conditions with least expenditure of energy and most satisfactory performance in use. Field tests have confirmed the conclusions of the laboratory studies.

Prolonging plow service.—Farmers of the United States have during the past 20 years purchased in round numbers from 540,000 to 1,250,000 plows annually, according to the United States Census Bureau. This immense consumption of one type of tillage machine may be attributed largely to replacements made necessary by the fact that plows and plowshares wear out rapidly under the severe conditions of service imposed upon them. The stations have constantly searched for ways and means of increasing the useful life of plows and reducing the expense of replacements and of time lost in making repairs during the plowing season.

As a means of prolonging plowshare service in case of very dry, hard, abrasive soils, the Idaho Station recommends, as a result of a study of the subject, the use of a tungsten-chromium-cobalt alloy applied with great care to the surface of the share. This alloy is very hard, does not rust, and is very resistant to abrasion. In tests of treated shares as compared with untreated shares, 74 acres were plowed at a cost of 16.3 cents per acre for treatment, whereas untreated shares had to be sharpened and pointed every second day at a cost of 43.8 cents per acre.

Rubber tires for farm tractors and machines.—The advantages and disadvantages of rubber tires for tractors and other farm machines have recently been given a great deal of study by many experiment stations, including particularly those of California, Idaho, Illinois, Indiana, Kansas, Louisiana, Michigan, Minnesota, Nebraska, Ohio, South Dakota, Texas, Virginia, and Wisconsin. The results of these studies to date have been practically 96 percent in favor of low-pressure pneumatic tires over steel tires for wheel tractors of the general-purpose type in the performance of numerous routine draft operations of the average farm under favorable soil conditions. They have indicated appreciable savings in fuel in the performance of the same draft operations expressed in terms of higher tractive efficiency and increased drawbar-pull capacity. Of considerable significance to the rubber industry is the fact that, according to the Department of Agriculture, there were about 920,000 tractors on the farms of the United States in 1930, the larger proportion of which were of the wheel type.

Much of the work on tires has been summarized from the practical standpoint by the Nebraska Station, which found that the pneumatic tire does not work well in mud. Where there was good solid footing for a tractor equipped with spade lugs to get traction, it pulled considerably more pounds at the drawbar than a rubber-tired tractor. However, in fields that had been plowed deeply and where the soil was very loose and lugs did not penetrate to hard ground, or on very sandy land, the pneumatic tires pulled more at the drawbar than when the tractor was equipped with steel wheels and spade lugs. An inflation pressure of 16 pounds seemed to be best for the rear wheel. For the front wheel, 26 pounds worked better than 15 pounds. It was found that if all the weight from the front end of the tractor were transferred to the rear, the reduction in travel could not be increased more than 3 or 4 percent. Therefore, nearly all travel reduction is due to slippage. With pneumatic tires most of the work was more efficiently accomplished than with steel wheels and lugs.

EXPERIMENT STATIONS IN ALASKA, HAWAII, AND PUERTO RICO

The administrative status of the experiment stations in Alaska, Hawaii, and Puerto Rico is constantly approaching that of the State experiment stations.

The Alaska Station is now under the immediate jurisdiction and is a department of the Alaska Agricultural College and School of Mines. It receives $15,000 annually as a result of extension of the Hatch Act to Alaska. It operates on budgets and projects approved by the Office of Experiment Stations, but has a large measure of freedom in choice of subjects for investigation and in the use of the funds provided by the Hatch Act. Its work is now confined primarily to the districts of Fairbanks in the Tanana Valley and of Matanuska in the Matanuska Valley, and deals mainly with possibilities of plant and animal production and dairying in these districts.

The Federal experiment station in Hawaii, associated with the University of Hawaii, had for the fiscal year 1934 a total income of $86,270 as compared with $94,500 for the previous year. The sources of this income were Hatch fund, $15,000; Adams fund, $11,000; direct appropriation through the Department of Agriculture, $36,270; and Territorial and university funds, $24,000. As in previous years the work of the station was directed mainly toward developing a more diversified and self-sustaining agriculture, leaving the problems of sugar and pineapple production, the leading agricultural industries of the Territory, largely to the well-organized research agencies supported by these industries. Looking to ultimate consolidation of agricultural-research agencies in Hawaii, an increasing degree of autonomy is being granted the station.

There was further development of coordination of agricultural research in Puerto Rico, as provided for in the act of Congress of March 4, 1931, extending the benefits of the Hatch and supplementary acts under certain limitations to Puerto Rico. The experiment station at Mayaguez operated with a Federal appropriation of $41,860 as compared with $63,560 for the previous year. During the year beginning July 1, 1934, the Territorial station at Rio Piedras will receive $25,000 of Hatch and Adams funds. The act of March 4, 1931, authorizing an increase annually to a total of $90,000 in the

fiscal year 1944, permits plans for coordinating the work of the Territorial and Federal stations to go forward consistently with the increase in Federal funds. As in previous years the Federal station continued to give major attention to improvements in culture of sugarcane and coffee, control of animal parasites, and general aid in the establishment of a more self-sustaining agriculture in the island.

CHANGES IN PERSONNEL

Changes in major positions at the experiment stations during the year ending June 30, 1934, were slightly higher than for the preceding period, averaging 54 as against 35 for the former year. Four deaths were reported.

Only two changes took place among the directors of the experiment stations. In July 1933 R. E. Buchanan, bacteriologist at the Iowa Station and dean of the graduate school, was elected director, filling the position vacant since 1932, when C. F. Curtiss retired. The president of the college, R. M. Hughes, served as acting director in the interim. G. E. Adams, dean of the School of Agriculture and director of the extension service, was made also director of the Rhode Island Station, succeeding B. E. Gilbert, who took over the duties of director of research. Changes which affected the duties of the directors occurred at three stations, as follows: H. P. Stuckey, director of the Georgia Station, served as dean of the College of Agriculture from July 1, 1933, to February 1, 1934. H. W. Barre, director of the South Carolina Station, was elected dean of the School of Agriculture, assuming these duties in August 1933. The director of the West Virginia Station, F. D. Fromme, was made also director of the extension service, taking this position in July 1933.

PUBLICATIONS

The stations issued 842 publications of the regular series during the past year as compared with 862 the previous year. Classified by scientific subjects these publications fall into the following groups: Meteorology, 13; soils and fertilizers, 50; field crops, 89; horticulture, 95; forestry, 3; plant diseases, 55; entomology and zoology, 63; foods and human nutrition, 33; rural-home management, 9; animal production, 79; dairying, 46; diseases of livestock, 30; agricultural engineering, 27; economics and sociology, 156; and annual reports and miscellaneous publications, 94. Classified by major objectives of the work, the publications, exclusive of certain purely regulatory and service publications, may be grouped approximately as follows: Improvement in crop production and products, 405; improvement in animal production and products, 188; and improvement in rural economic and social conditions, 215.

In addition to their regular series of publications, the stations contributed 1,373 articles reporting or based on their work to 63 outside technical or scientific journals, and 30 of the stations contributed or collaborated in 90 articles published in the Journal of Agricultural Research. The published output of the stations as measured by these figures was substantially the same as in the previous year.

The amount of station funds expended for publications was $246,696 as compared with $278,220 the previous year.

INCOME, EXPENDITURES, AND OTHER STATISTICS, 1934

By J. I. Schulte

The following tables give detailed data regarding: (1) Personnel, publications, and mailing lists of the experiment stations; (2) revenues and additions to equipment; (3) expenditures from the Hatch, Adams, and Purnell funds; (4) expenditures from the supplementary funds; and (5) total disbursements from the United States Treasury under the Hatch, Adams, and Purnell Acts from their passage to the end of the fiscal year, June 30, 1934.

Table 5.—*Personnel, publications, and mailing lists of the experiment stations, 1934*

Station	Date of original organization	Date of organization under Hatch Act	Persons on staff	Teachers on staff	Persons on staff assisting in extension work	Publications during fiscal year		Names on mailing list
						Number	Pages	
Alabama	February 1883	Feb. 24, 1888	56	30	1	9	150	4,000
Alaska	—— 1898	——	2	1	0	0	0	227
Arizona		—— 1889	47	36	0	138	563	9,000
Arkansas		—— 1887	47	37	2	16	306	5,500
California	—— 1875	March 1888	215	112	133	60	3,161	10,618
Colorado		Feb. 29, 1888	68	41	4	24	576	900
Connecticut (State)	Oct. 1, 1875	May 18, 1887	45	0	0	37	973	14,223
Connecticut (Storrs)		do	31	11	7	8	352	10,500
Delaware		Feb. 21, 1888	23	8	7	8	254	8,500
Florida		—— 1888	76	4	5	38	506	12,000
Georgia	Feb. 18, 1888	July 1, 1889	30	0	0	9	128	6,000
Hawaii	—— 1901	——	15	7	1	8	201	1,148
Idaho		Feb. 26, 1892	55	31	10	35	649	16,575
Illinois		Mar. 21, 1888	115	74	11	27	1,316	31,425
Indiana	—— 1885	January 1888	108	28	6	154	1,098	38,850
Iowa		Feb. 17, 1888	125	66	8	67	1,488	25,018
Kansas		Feb. 8, 1888	113	89	0	107	455	12,000
Kentucky	September 1885	April 1888	74	26	7	10	290	7,202
Louisiana	April 1886	——	47	7	2	21	370	4,780
Maine	March 1885	Oct. 1, 1887	35	5	0	16	878	14,200
Maryland	—— 1888	April 1888	62	35	6	52	486	32,000
Massachusetts	—— 1882	Mar. 2, 1888	80	21	0	44	466	16,600
Michigan		Feb. 26, 1888	127	75	5	23	1,050	15,318
Minnesota	Mar. 17, 1885	—— 1888	164	108	3	108	776	13,000
Mississippi		Jan. 27, 1888	50	17	2	2	16	15,000
Missouri		January 1888	84	66	4	107	1,166	5,010
Montana		July 1, 1893	42	17	6	23	572	5,000
Nebraska	Dec. 16, 1884	June 13, 1887	61	37	0	18	792	12,000
Nevada		December 1887	17	1	0	19	303	3,500
New Hampshire	—— 1886	Aug. 4, 1887	50	27	6	18	336	8,000
New Jersey (College)		Apr. 26, 1888	36					
New Jersey (State)	Mar. 10, 1880		[1] 79	39	7	157	2,331	12,000
New Mexico		Dec. 14, 1889	27	14	0	59	410	10,000
New York (Cornell)	—— 1879	April 1888	143	107	10	62	2,747	4,322
New York (State)	March 1882		72	0	0	91	1,228	10,000
North Carolina	Mar. 12, 1877	Mar. 7, 1887	44	13	4	23	673	12,000
North Dakota		March 1890	54	24	2	31	635	8,975
Ohio	Apr. 25, 1882	Apr. 2, 1888	108	24	2	80	1,026	36,835
Oklahoma		Oct. 27, 1890	65	43	0	53	281	6,300
Oregon		July 1888	98	39	4	45	1,038	1,785
Pennsylvania		June 30, 1887	131	123	0	83	826	30,800
Puerto Rico	—— 1901	——	7	0	0	5	95	1,900
Rhode Island		July 30, 1888	24	21	5	16	324	3,100
South Carolina		January 1888	51	15	4	16	530	6,000
South Dakota		Mar. 13, 1887	36	30	4	19	551	5,000
Tennessee	June 8, 1887	Aug. 4, 1887	36	7	0	17	240	19,256
Texas		Apr. 3, 1889	117	1	1	77	1,048	80,669
Utah		—— 1890	39	26	7	76	565	10,000
Vermont	Nov. 24, 1886	Feb. 28, 1888	28	13	1	14	541	3,600
Virginia	—— 1888	—— 1891	50	18	7	26	648	12,000
Washington		—— 1891	52	28	0	45	834	1,516
West Virginia		June 11, 1888	49	26	7	19	253	12,000
Wisconsin	——1883	—— 1887	133	85	41	10	511	54,293
Wyoming		Mar. 1, 1891	38	19	0	10	358	8,750
Total			3,567	1,732	342	2,240	37,370	709,195

[1] Including 14 who are on college staff but not included in total.

TABLE 6. *Revenues and expenditures*

Station	Revenues						
	Federal			State	Balance from previous year [1]	Fees	Sales
	Hatch fund	Adams fund	Purnell fund				
Alabama	$15,000	$15,000	$60,000	$74,490.58	$78,323.65		$34,905.45
Alaska	15,000			3,000.00	3.14		2,423.15
Arizona	15,000	15,000	60,000	72,031.61	3,541.47		1,534.06
Arkansas	15,000	15,000	60,000	47,958.42	725.67		16,389.65
California	15,000	15,000	60,000	772,364.88	15,805.57		31,636.06
Colorado	15,000	15,000	60,000	79,662.76	25,490.41		28,427.43
Connecticut (State)	7,500	7,500	30,000	178,391.13		$22,500.00	
Connecticut (Storrs)	7,500	7,500	30,000	33,758.00		3,141.99	1,358.45
Delaware [2]	15,000	15,000	60,000	19,000.00	3,304.49		13,035.84
Florida	15,000	15,000	60,000	301,321.50	13,442.66		12,782.08
Georgia	15,000	15,000	60,000	10,890.50	10,599.21		14,391.76
Hawaii [2 3]	15,000	11,000		6,669.43			15,025.35
Idaho	15,000	15,000	60,000	18,667.47	610.63		5,895.04
Illinois [2]	15,000	15,000	60,000	326,490.86			30,648.71
Indiana	15,000	15,000	60,000	220,000.00	141,257.03	111,339.86	80,523.35
Iowa	15,000	15,000	60,000	192,562.75	5,260.69		34,688.49
Kansas	15,000	15,000	60,000	95,639.54	21,775.30	49,709.07	
Kentucky	15,000	15,000	60,000	101,941.26	15,723.99	94,211.89	31,158.60
Louisiana	15,000	15,000	60,000	36,093.00	1,763.78	23,999.38	15,763.29
Maine	15,000	15,000	60,000	24,000.00		12,386.02	14,355.10
Maryland	15,000	15,000	60,000	65,593.54	5,348.59		14,927.11
Massachusetts	15,000	15,000	60,000	154,990.48		57,167.26	2,999.31
Michigan	15,000	15,000	60,000	237,808.19			25,010.07
Minnesota	15,000	15,000	60,000	314,275.74		440.00	50,359.70
Mississippi	15,000	15,000	60,000	58,355.00	17,596.63		27,336.90
Missouri	15,000	15,000	60,000	35,017.82	23,151.18	18,876.05	27,154.33
Montana	15,000	15,000	60,000	68,270.61	2.06		30,342.34
Nebraska	15,000	15,000	60,000	113,296.61			47,094.44
Nevada	15,000	15,000	60,000	2,217.83	3,821.29		3,093.92
New Hampshire	15,000	15,000	60,000	7,076.37	9,720.27		2,198.87
New Jersey (College)	15,000	15,000	60,000				
New Jersey (State)				348,600.00		44,361.66	46,627.49
New Mexico	15,000	15,000	60,000	5,400.00	33,452.20		14,270.54
New York (Cornell)	13,500	13,500	54,000	602,772.10			56,419.91
New York (State)	1,500	1,500	6,000	356,689.75	5,345.23		9,355.49
North Carolina	15,000	15,000	60,000	84,148.94	2,307.53		8,213.28
North Dakota	15,000	15,000	60,000	21,166.52	34,613.23	315.00	31,134.16
Ohio	15,000	15,000	60,000	538,587.11	93,522.89		50,348.67
Oklahoma	15,000	15,000	60,000	61,733.41	25,177.48		27,395.94
Oregon	15,000	15,000	60,000	88,206.81	37,992.69	618.67	46,928.87
Pennsylvania	15,000	15,000	60,000	125,668.79	1,548.12		25,935.58
Puerto Rico [3]							
Rhode Island	15,000	15,000	60,000				5,589.03
South Carolina	15,000	15,000	60,000	42,312.98	10,258.28		60,623.35
South Dakota	15,000	15,000	60,000	16,560.00	8,440.47		10,970.19
Tennessee	15,000	15,000	60,000	22,984.84			9,949.27
Texas	15,000	15,000	60,000	241,961.00	62,234.27		98,775.84
Utah	15,000	15,000	60,000	35,000.00			30,540.41
Vermont	15,000	15,000	60,000		538.20	20,958.25	505.35
Virginia	15,000	15,000	60,000	71,365.00	7,855.95		6,759.90
Washington	15,000	15,000	60,000	27,753.14			47,191.67
West Virginia	15,000	15,000	60,000	41,750.00			28,272.84
Wisconsin	15,000	15,000	60,000	265,929.00			57,452.00
Wyoming	15,000	15,000	60,000	34,043.96	19,503.47		21,488.86
Total	750,000	731,000	2,880,000	6,704,469.23	740,062.72	460,025.10	1,310,207.49

[1] Not including balances from Federal funds.

[2] Including unexpended balances—Delaware, Purnell $724.82; Hawaii, Hatch $80.83; Illinois, Hatch $79.98, Adams $56.71, Purnell $1,094.15.

[3] Support from direct appropriations to the U. S. Department of Agriculture given under Miscellaneous.

for additions to equipment, 1934

Revenues—Continued		Additions to equipment						
Miscellaneous	Total	Buildings	Library	Apparatus	Farm implements	Livestock	Miscellaneous	Total
$2,917.67	$280,637.35	$4,966.30	$656.35	$2,784.38	$4,908.99	$476.16		$13,792.18
	20,426.29	1.90	25.00	57.42	1,167.11	300.00	$961.02	2,512.45
	167,107.14	170.00		3,026.30	46.00	200.00	2,095.57	5,537.87
1,343.77	156,417.51	5,305.69	797.68	6,483.89	2,266.68	531.67	1,509.02	16,894.63
61,430.86	971,237.37	37,401.49	7,000.00	5,900.00	9,850.00	6,300.00	1,645.46	68,096.95
	223,580.60	8,191.00	502.00	3,932.00	3,815.00	2,775.00	1,086.00	20,301.00
4,300.00	250,191.13	4.61	1,696.86	1,378.08	6,482.63		1,205.55	10,767.73
	83,258.44	762.43	700.00	759.10	98.04		364.57	2,684.14
	125,340.33	2,044.33	1,159.19	2,414.46	925.31	300.00		6,843.29
	417,546.24	7,443.79	1,977.40	10,347.87	10,073.84	2,496.65	946.15	33,285.70
	125,881.47	5,966.06	1,027.25	1,450.50	4,876.10	7,799.14		21,119.05
32,344.00	80,038.78	61.20	218.31	987.91	170.33	25.00	82.75	1,545.50
	115,173.14	4,500.00	500.00	1,000.00	500.00	2,000.00	2,000.00	10,500.00
9,529.83	456,669.40	3,515.08	4,176.84	4,008.90			12,304.97	24,005.79
73,783.11	716,903.35	12,366.72	2,957.13	4,381.60	1,196.49	762.47	2,595.96	24,260.37
7,680.00	330,191.93			964.29	97.95			1,062.24
5,026.00	262,149.91	5,692.86	55.43	2,670.87	8,407.27	4,863.17	801.06	22,490.66
	333,035.74		95.93	1,946.03	2,454.23	1,248.29	3,136.26	8,880.74
1,584.87	169,204.32	1,774.50	39.40	689.15	3,163.99	113.93	2,032.63	7,813.60
	140,741.12	1,853.13	1,426.55	2,690.97	1,441.88	867.70	2,754.00	11,034.23
12,172.72	188,041.96	3,196.03	648.39	7,933.92	1,572.52	183.35	457.98	13,992.19
4,744.96	309,902.01	664.78	705.15	1,778.75	2,141.28	281.32	1,011.29	6,582.57
	352,818.26	950.00	1,227.00	2,368.00	2,506.00	179.00	4,798.00	12,028.00
4,617.40	459,692.84	15,536.09	1,530.64	1,614.21	4,595.35	3,756.77	9,587.39	36,620.45
	193,288.53	225,114.50	5,136.59	20,211.60	29,677.96	26,412.00	19,945.57	326,498.22
17,586.71	211,786.09	4,900.00	290.00	3,500.00	3,000.00	1,100.00	560.00	13,350.00
	188,615.01	4,448.00	503.00	636.00	2,283.00	175.00	908.00	8,953.00
	250,391.05	9,399.29	194.93	3,463.27	2,101.42	11,016.31	69,610.04	95,785.26
	99,133.04	1,500.00	339.81	1,251.53	1,790.00	1,013.73	9,334.40	15,229.47
28,898.52	137,894.03	1,055.92	97.08	571.76	305.09	7.50	308.87	2,346.22
	90,000.00							
7,136.00	446,725.15		584.26	3,068.01	800.00			4,452.27
	143,122.74	8,663.14	22.67	793.05	2,519.16	665.00	737.00	13,400.02
8,321.04	748,513.05	3,749.77	2,113.54	121,790.51	16,126.86	775.76	7,211.14	151,767.58
8,724.17	389,114.64	8,364.16	2,087.95		10,206.42		235,595.71	256,254.24
5,463.80	190,133.55	8,538.95	770.84	4,342.03	3,430.00	2,177.15		19,258.97
465.00	177,693.91	1,231.77	361.22	1,458.01	250.59	2,859.20	252.50	6,413.29
7,527.00	779,985.67		681.77	598.76	7,469.63	5,679.21	31.49	14,460.86
48,470.00	252,776.83	18,207.71	1,084.50	2,013.63	3,200.00	1,476.96	1,524.56	27,507.36
11,272.45	275,019.49	310.95	137.66	1,757.66	3,010.07	2,143.00	2,321.59	9,680.93
	243,152.49		198.30	1,043.10	290.93		107.11	1,639.44
37,629.00	37,629.00	630.46	65.51	125.40	41.35			862.72
	95,589.03	553.00	200.00	2,553.00	2,173.00	38.00	1,458.00	6,975.00
	203,194.61	11,576.73	1,001.35	7,318.06	8,649.50	2,735.37	118.71	31,399.72
3,057.66	129,028.32		420.00	2,400.00	410.00			3,230.00
	122,934.11	6,399.19	1,092.83	3,888.60	5,087.29	642.50	16,683.52	33,793.93
86,986.43	579,957.54	4,762.99	1,861.88	5,828.86	6,367.45	12,079.89	4,222.97	35,124.04
700.00	156,240.41	723.00	676.60	3,669.60	476.99	136.00	56.70	5,738.89
	112,001.80	3,239.79	400.16	2,830.40	2,146.06			8,616.41
	175,980.85	5,514.70	654.34	2,555.68	117.40		1,631.77	10,473.89
2,309.68	167,254.49	3,536.10	1,484.89	2,511.77	3,072.51	946.23	443.16	11,994.66
300.00	160,322.84	3,000.00	393.25	1,810.73	5,751.92	429.40		11,385.30
116,368.00	529,749.00		1,647.68	3,952.51	1,026.97	3,262.52	972.24	10,861.92
	165,041.29	4,136.04	300.00	860.75	1,692.71	979.83	912.63	8,881.96
612,690.65	14,188,455.19	461,924.15	53,925.11	278,372.88	196,231.27	112,210.18	426,323.31	1,528,986.90

TABLE 7.—*Expenditures from United States appropriations received under*

Station	Amount of appropriation	Classified expenditures							
		Salaries	Labor	Publications	Postage and stationery	Freight and express	Heat, light, water, and power	Chemical supplies	Seeds, plants, and sundry supplies
Alabama	$15,000	$11,629.25	$1,895.90	$157.50	$170.48	$55.63	$62.79	$52.78	$199.66
Alaska	15,000	3,118.84	4,324.80	160.01	163.29	1,230.08	1,264.81	12.97	477.76
Arizona	15,000	14,999.04			.96				
Arkansas	15,000	6,738.97	2,185.23	63.48	223.92	244.36	384.16	466.14	462.18
California	15,000	15,000.00							
Colorado	15,000	15,000.00							
Connecticut (State)	7,500	7,500.00							
Connecticut (Storrs)	7,500	7,500.00							
Delaware	15,000	7,813.67	1,573.17	541.75	1,651.06	54.76	309.99	268.55	138.92
Florida	15,000	15,000.00							
Georgia	15,000	6,221.66	2,319.11	347.26	752.85	180.06	451.89	75.97	789.23
Hawaii [1]	15,000	7,146.00	2,999.12	928.50	111.56	16.15	119.50	289.18	213.85
Idaho	15,000	6,759.17	2,806.52	2,136.89	1,328.94	40.97	13.40	142.96	162.44
Illinois [2]	15,000	14,090.38	134.92	443.50	98.73	2.47			
Indiana	15,000	15,000.00							
Iowa	15,000	9,454.01	247.48	1,105.59	364.05	.55	3.39	77.39	780.90
Kansas	15,000	9,700.00	4,640.38	36.02	5.56		3.75	164.72	32.12
Kentucky	15,000	14,758.40		198.39					
Louisiana	15,000	9,364.34	3,642.21	819.84	111.79	3.17	115.84	35.69	101.84
Maine	15,000	8,450.00	1,154.12	115.45	849.50	120.26	1,276.87	70.95	168.43
Maryland	15,000	13,582.86	769.50	563.26	69.10			15.28	
Massachusetts	15,000	14,805.44							
Michigan	15,000	15,000.00							
Minnesota	15,000	13,776.53		4.00	6.03	9.59		103.04	281.28
Mississippi	15,000	9,819.96	743.22	4.90	334.49	68.66	584.63	15.75	631.14
Missouri	15,000	9,781.28	1,935.63	935.09	262.04	19.31	28.50	254.74	176.27
Montana	15,000	8,778.29	2,091.09	282.07	387.79	45.19	19.00	51.24	189.01
Nebraska	15,000	15,000.00							
Nevada	15,000	8,631.56	2,009.93	334.12	1,048.46	24.99	198.36	2.81	503.90
New Hampshire	15,000	9,196.10	946.67	779.91	1,395.50	316.08	706.34	34.25	257.48
New Jersey	15,000	8,564.72	936.55	417.90	803.26	.13		107.23	199.25
New Mexico	15,000	7,561.29	4,309.53	904.38	279.94	52.26	307.44	144.59	512.79
New York (Cornell)	13,500	8,169.58	2,278.44		154.06	12.23		376.01	270.69
New York (State)	1,500	1,376.80	123.20						
North Carolina	15,000	12,344.20	212.24	914.95	118.70	50.51		41.89	150.22
North Dakota	15,000	11,860.87	3,139.13						
Ohio	15,000	8,950.00		244.08	492.05		1,899.51	89.49	476.78
Oklahoma	15,000	5,860.92	5,110.90	219.80	76.87	63.85	12.00	623.04	428.34
Oregon	15,000	7,950.00	4,460.17	956.07	93.09	4.17	110.38	23.38	62.55
Pennsylvania	15,000	12,924.66	758.26	1,120.72		8.61			5.81
Rhode Island	15,000	7,781.33	2,963.80	468.61	395.56	181.50	436.63	299.39	561.72
South Carolina	15,000	7,329.00	1,812.87	690.63	848.94	22.34	20.04	127.84	310.19
South Dakota	15,000	7,855.00	1,688.97	1,664.61	146.75	91.92	12.36	264.02	552.12
Tennessee	15,000	9,464.00	2,561.63	668.29	504.72	36.16	11.40	137.31	108.94
Texas	15,000	11,875.00	615.50		309.93	6.16		24.19	152.57
Utah	15,000	7,952.40	3,315.14	1,027.31	129.07	15.30	17.50	182.78	126.91
Vermont	15,000	7,757.32	945.11	2,558.84	278.48	5.04	888.84	276.44	364.32
Virginia	15,000	7,315.92	4,004.15	1,084.74	191.20	21.19	44.31	112.12	412.07
Washington	15,000	8,017.37	1,629.43	3,152.06	234.63		12.17	180.45	230.63
West Virginia	15,000	3,195.00	4,136.94	113.40	6.50	181.72	109.65	367.39	762.04
Wisconsin	15,000	11,377.80	2,303.90					22.81	
Wyoming	15,000	5,039.49	6,061.27	127.25	628.96	152.32	360.70	56.18	599.61
Total	750,000	504,138.47	89,786.13	26,291.17	15,028.81	3,337.69	9,786.15	5,590.96	11,853.96

[1] Including balance from previous year $80.83.

[2] Including balance from previous year $79.98.

the act of March 2, 1887 (Hatch Act), for the year ended June 30, 1934

Classified expenditures—Continued

Fertilizers	Feeding stuffs	Library	Tools, implements, and machinery	Furniture and fixtures	Scientific apparatus	Livestock	Travel expenses	Contingent expenses	Buildings and land	Balance
$36.00		$332.47	$143.18	$144.25			$100.13	$19.98		
160.90	$1,001.38	25.00	2,576.04	46.05	$57.42	$300.00		78.75	$1.90	
234.13	2,973.55		547.18		272.65		199.05	5.00		
107.78		824.50	89.05	624.45	676.83		305.93	7.00	12.59	
648.57	297.35	349.11	1,480.37	89.80	104.34	58.60	639.21		194.62	
68.53	2,538.27	23.08	7.35		106.75	25.00	296.64	49.32	61.20	
	5.30		200.84	266.97	323.16		636.68	1.20	174.56	
				230.00						
	781.26		39.00		248.60	1,500.00	397.78			
			15.70		36.44		365.31			
							43.21			
200.04			171.68	1.06		4.50	327.96	23.70	76.34	
32.60	415.85	1,195.98	65.28	80.42	69.37	27.30	826.63	34.71	46.28	
							194.56			
	76.75		50.38			4.50	673.85	14.05		
	59.50	5.00	1,549.05	11.35	4.86	785.45	133.79	72.88	175.37	
	272.58	67.95	37.86	157.50	151.89	100.00	71.90		747.46	
	1,181.14	382.92	540.73	139.64			911.89			
	567.79	55.25	177.14	407.70		21.00	365.11	159.00	492.88	
80.93		523.28	58.84	268.60	72.34		316.30	23.38	24.00	
611.35	360.00	561.99	30.43	1,439.73	127.63		667.46	88.20	84.17	
81.35	109.70	9.70	507.04	78.93	84.15				56.91	
53.00			15.52	33.10	2,137.37					
10.60		51.01	6.00	69.72	12.81		1,016.57	.58		
452.16	2,255.11		140.82							
	793.49	68.69	499.52	60.52	58.09	198.75	351.20		574.02	
	10.51		198.88	523.25	150.00		455.55	2.00		
125.40			56.54							
182.13	182.54	59.57	776.32	81.85	185.73		155.25	7.60	280.42	
414.40	314.26	966.89	915.95	83.44	179.84		233.20	30.17	700.00	
7.75	734.59	18.00	593.65	198.96	12.00	410.00	508.73	7.86	232.71	
	30.00	239.73	896.71	260.00			75.23	5.88		
	121.80	11.35	730.14	680.56	15.00		348.40		109.40	
	1,288.34	91.91	120.84	56.00			669.40		7.10	
96.74		168.80	281.56	184.13	40.25		337.86	90.92	725.35	
161.61	639.35	81.85	295.58	39.90	497.14		91.47		7.40	
		54.15	48.85	61.60	49.66		1,304.00		25.00	
421.62	2,518.46		1,976.19	90.19	348.20	165.00	435.59	7.85		$164.26
						1,168.00	127.49			
	987.10	3.00	446.70	248.27	35.77		151.38	2.00	100.00	
4,187.59	20,515.97	6,171.18	16,286.91	6,657.94	6,058.29	4,768.10	13,734.71	732.03	4,909.68	164.26

TABLE 8.—*Expenditures from United States appropriations received under*

Station	Amount of appropriation	Classified expenditures						
		Salaries	Labor	Postage and stationery	Freight and express	Heat, light, water, and power	Chemical supplies	Seeds, plants, and sundry supplies
Alabama	$15,000	$11,538.47	$516.12	$20.17	$70.57	$231.07	$1,657.45	$365.03
Arizona	15,000	10,000.08	2,018.75	80.27	45.67		450.83	176.44
Arkansas	15,000	9,435.42	1,835.15	160.91	32.25	55.68	1,295.17	321.90
California	15,000	15,000.00						
Colorado	15,000	15,000.00						
Connecticut (State)	7,500	7,500.00						
Connecticut (Storrs)	7,500	7,500.00						
Delaware	15,000	10,371.00	1,967.52	7.25	34.43		790.96	567.43
Florida	15,000	15,000.00						
Georgia	15,000	9,570.31	1,312.85	30.54	235.53	324.91	1,285.88	98.52
Hawaii	11,000	9,357.66	274.63	4.46	25.09		351.55	48.10
Idaho	15,000	11,659.40	992.94	12.99	18.38	7.46	1,520.60	73.14
Illinois [1]	15,000	7,149.56	7,850.44					
Indiana	15,000	12,187.00	1,019.97	3.90	19.44		583.45	152.98
Iowa	15,000	10,965.79	2,215.10	93.44	43.06	6.28	674.07	451.32
Kansas	15,000	10,448.00	4,091.38	2.40			42.03	53.24
Kentucky	15,000	14,855.97	17.25			25.20	101.58	
Louisiana	15,000	11,031.26	1,995.53	33.85	39.01		808.48	143.04
Maine	15,000	15,000.00						
Maryland	15,000	12,505.00	504.00				262.85	54.46
Massachusetts	15,000	14,888.28						
Michigan	15,000	15,000.00						
Minnesota	15,000	14,789.05		1.45			66.57	32.02
Mississippi	15,000	10,830.06	2,858.98		15.38	249.18	219.94	270.28
Missouri	15,000	2,959.45	5,571.55	154.43	206.08	187.05	2,240.14	628.19
Montana	15,000	9,464.72	2,952.69	16.22	6.37		748.80	269.86
Nebraska	15,000	15,000.00						
Nevada	15,000	7,510.38	3,346.63	37.75	37.02		638.73	84.21
New Hampshire	15,000	11,962.60	1,013.83	5.87	18.37	.96	249.89	86.25
New Jersey	15,000	9,504.80	562.55	95.03	5.67	651.92	1,412.12	299.81
New Mexico	15,000	8,670.38	2,840.67	57.11	72.49	382.24	785.33	203.79
New York (Cornell)	13,500	11,001.25	782.35		11.25		171.04	591.95
New York (State)	1,500	1,224.17						
North Carolina	15,000	11,885.40	281.20	12.80	37.94	51.61	697.30	86.83
North Dakota	15,000	14,900.44	99.56					
Ohio	15,000	14,161.67	667.70	11.33				40.30
Oklahoma	15,000	8,184.34	2,246.95	30.95	5.04		1,773.48	255.11
Oregon	15,000	10,684.59	2,345.45	48.41	15.31	73.56	921.46	87.12
Pennsylvania	15,000	14,820.00	180.00					
Rhode Island	15,000	9,938.88	2,697.58	55.04	2.20	137.62	164.62	22.50
South Carolina	15,000	9,796.15	1,317.73	286.75	46.39	222.59	243.29	302.58
South Dakota	15,000	8,390.50	2,803.95	36.36	74.06	1.40	745.77	713.41
Tennessee	15,000	10,609.20	642.82	2.28	41.57	93.83	574.06	55.62
Texas	15,000	11,637.50	782.50	7.31	61.44	1.00	874.11	78.40
Utah	15,000	8,009.13	3,420.46	43.83	37.92		825.47	169.41
Vermont	15,000	9,628.76	3,030.28	36.50	28.22	2.89	344.67	199.66
Virginia	15,000	10,986.44	2,476.42	4.50			122.17	134.42
Washington	15,000	12,515.16	1,513.06	12.81			650.50	42.77
West Virginia	15,000	10,730.00	2,258.83	11.19		53.82	179.53	98.39
Wisconsin	15,000	12,160.67	2,003.53				168.40	
Wyoming	15,000	11,127.55	1,511.65	41.01	59.49		616.84	257.73
Total	731,000	558,446.44	76,820.55	1,459.11	1,345.64	2,760.27	25,259.13	7,516.21

[1] Including balance from previous year, $56.71.

the act of Mar. 16, 1906 (Adams Act), for the year ended June 30, 1934

Classified expenditures—Continued

Fertilizers	Feeding stuffs	Library	Tools, implements, and machinery	Furniture and fixtures	Scientific apparatus	Livestock	Travel expenses	Contingent expenses	Buildings and land	Balance
$8.25	$16.10		$175.27	$77.10	$214.45	$4.00	$93.70	$12.25		
57.34			44.27	736.14	242.82		953.43	23.96	$170.00	
46.11	244.00	$12.38	100.46	46.50	1,202.55		204.02		7.50	
3.57		15.32	19.87	4.45	799.51		403.99	14.70		
223.40	771.16		154.58	19.56	940.82	15.00	8.95		7.99	
26.55	113.06		11.25	10.20	699.55		32.15	45.75		
	1.25		105.60	3.00	461.44		116.60	22.20	5.00	
6.75	240.78				609.33	176.40				
10.00	401.34		17.50	12.00	21.49	27.00	57.61	4.00		
	187.00		140.48		23.47	12.00				
	245.90	5.00	39.63	29.50	178.60	58.68	194.62	24.44	172.46	
			11.10		1,662.59					
									111.72	
			3.25				106.76	.90		
218.92	42.00		290.31		2.45	2.50				
111.13	1,377.07	8.96	176.63		447.85	161.79	24.18		745.50	
44.39		16.15	406.98		152.84	19.00	901.98			
	1,709.66		918.30	126.25	126.12	276.68	188.27			
26.88	514.32		57.71	27.30	662.37		72.93	22.00	278.72	
	.55	119.46	14.94	589.32	961.62		90.27	45.71	646.23	
182.97		12.23	654.71	28.67	596.34			3.00	510.07	
32.60			51.12		858.44					
										$275.83
4.95					1,328.03		296.94		317.00	
	93.00		26.00							
7.34	1,566.93	22.46	184.34	39.20	298.83		77.49		307.54	
12.25	6.45	24.94	122.39		402.90		196.76	36.29	22.12	
153.50	655.78	5.85	336.92		497.93				331.58	
			890.25	15.26	1,246.29		201.15	60.13	371.44	
111.41	338.60	245.78	115.97	516.86	211.91	10.00	684.02			
2.60		112.12	63.20	131.99	2,542.36		94.10		34.25	
	480.35			8.75	956.14	112.50				
	11.05	21.40	169.98	19.40	1,766.49	40.00	242.87		222.59	
6.62		32.70	210.03	88.29	1,669.25		61.32		260.81	
	272.00		84.90	26.54	114.13	32.00	146.88		599.60	
			6.96	8.50	53.50		196.74			
	330.71				489.42	2.84				845.27
	667.40									
	309.96	6.30	20.50		320.42	198.50	499.00	31.05		
1,297.53	10,596.42	661.05	5,625.40	2,564.78	22,762.25	1,148.89	6,146.73	346.38	5,122.12	1,121.10

TABLE 9.—*Expenditures from United States appropriations received under*

Station	Amount of appropriation	Classified expenditures							
		Salaries	Labor	Publications	Postage and stationery	Freight and express	Heat, light, water, and power	Chemical supplies	Seeds plants, and sundry supplies
Alabama	$60,000	$41,338.26	$6,780.40	$234.82	$308.05	$509.04	$796.80	$1,780.02	$1,639.16
Arizona	60,000	39,213.14	5,790.41	509.37	226.55	397.19	103.48	2,856.38	974.75
Arkansas	60,000	43,435.45	2,532.14	3,880.30	631.75	137.08	73.18	2,343.42	384.54
California	60,000	58,460.40	1,539.60						
Colorado	60,000	43,792.14	5,924.14	1,027.07	711.88	26.14	23.80	1,663.66	215.88
Connecticut (State)	30,000	22,888.50	3,925.26		80.12	10.53	12.40	866.76	217.77
Connecticut (Storrs)	30,000	24,200.75	2,277.50	4.30	576.60	2.99		71.20	
Delaware [1]	60,000	36,390.22	9,835.66	1,808.73	76.82	21.09	958.24	747.13	563.90
Florida	60,000	34,066.24	10,198.72		299.42	136.55	26.65	3,916.30	527.86
Georgia	60,000	37,266.36	6,890.37	698.57	264.07	525.04	2,403.87	647.16	1,484.12
Idaho	60,000	39,079.55	9,669.16	815.89	472.19	319.79	159.97	1,874.46	267.09
Illinois [2]	60,000	26,521.39	10,801.30	4,223.66	1,139.76	94.90	26.50	446.77	290.21
Indiana	60,000	40,498.25	6,882.25	1,270.42	321.79	36.38		685.28	451.30
Iowa	60,000	41,132.87	9,687.33	20.33	1,227.34	232.84	56.75	1,128.42	1,135.06
Kansas	60,000	37,614.25	17,742.45	24.22	32.79	13.02	3.88	1,445.21	434.88
Kentucky	60,000	53,988.48	1,762.01	889.02	127.98	12.65	28.80	571.70	90.64
Louisiana	60,000	43,818.22	8,458.82	575.00	382.30	236.99	272.51	466.12	423.59
Maine	60,000	36,186.07	7,280.13	23.00	628.66	370.96	1,179.55	794.03	736.08
Maryland	60,000	44,699.76	3,648.47	825.28	110.37	34.66	20.44	1,691.57	849.03
Massachusetts	60,000	49,692.50	3,330.26	453.01	556.28			842.27	163.51
Michigan	60,000	46,483.40	5,985.77	1,406.15	369.04	3.79		644.87	150.29
Minnesota	60,000	48,837.05	315.45	1,262.63	41.53	171.72	4.99	522.27	579.13
Mississippi	60,000	39,314.36	10,557.26	5.25	668.07	247.01	1,966.60	1,165.86	1,110.03
Missouri	60,000	14,270.01	18,025.26	1,767.85	363.10	317.48	139.01	4,221.93	873.45
Montana	60,000	31,374.38	17,037.40	1,284.89	324.22	248.42	181.41	831.51	1,887.45
Nebraska	60,000	36,151.61	9,159.30	2,146.74	120.55	52.75	111.13	850.84	398.29
Nevada	60,000	30,650.22	14,700.90	557.17	772.23	232.01	250.42	764.31	1,275.54
New Hampshire	60,000	41,793.60	6,962.87	508.11	259.80	239.83	29.90	795.31	1,222.95
New Jersey	60,000	45,899.44	4,167.11	262.03	210.42	44.98	242.15	1,517.47	456.02
New Mexico	60,000	28,258.43	11,331.21	2,174.41	582.04	491.01	661.51	267.37	1,098.56
New York (Cornell)	54,000	43,452.07	992.68		145.39	3.00		306.41	109.43
New York (State)	6,000	4,214.88	1,580.36						
North Carolina	60,000	40,260.13	5,009.08	1,084.56	389.56	116.24	179.92	1,293.95	278.74
North Dakota	60,000	46,471.42	4,756.64	1,902.98	110.93	96.94	10.75	759.34	79.50
Ohio	60,000	45,280.38	6,009.16	80.00	47.35		482.72	182.28	114.24
Oklahoma	60,000	29,521.65	15,428.93	545.12	400.76	89.88	243.73	2,029.88	606.08
Oregon	60,000	39,021.22	9,683.12	2,020.17	312.38	71.20	628.17	885.85	419.57
Pennsylvania	60,000	48,724.24	4,522.29	1,095.47	170.95	16.74	28.00	570.42	159.49
Rhode Island	60,000	39,415.62	7,898.75	465.63	271.27	42.12	730.86	991.48	225.98
South Carolina	60,000	35,490.74	6,017.31	1,333.45	705.67	134.50	438.65	1,013.30	410.93
South Dakota	60,000	31,547.32	11,967.18	3,450.18	847.73	169.08	56.99	2,183.28	608.20
Tennessee	60,000	41,794.18	5,429.88	962.54	595.84	256.88	524.36	1,297.49	548.17
Texas	60,000	34,547.70	13,880.12		552.74	127.44	38.35	990.18	429.74
Utah	60,000	30,019.28	18,363.72	1,478.58	583.94	210.57	40.21	1,181.39	786.68
Vermont	60,000	35,096.87	9,034.95	1,745.13	1,094.13	121.50	2,433.86	1,057.09	432.53
Virginia	60,000	33,047.64	12,719.58	2,574.70	506.45	20.68	83.34	336.45	319.47
Washington	60,000	37,595.55	10,458.05	627.64	566.22	46.88	6.07	2,450.53	1,379.26
West Virginia	60,000	37,257.50	7,984.82	221.84	66.75	848.63	92.58	917.82	584.88
Wisconsin	60,000	38,760.57	11,923.20					3,673.11	
Wyoming	60,000	33,943.93	10,850.21	1,625.19	96.83	350.24	482.02	854.73	1,585.92
Total	2,880,000	1,882,778.19	407,708.94	49,871.40	19,350.61	7,889.36	16,234.52	59,394.58	28,979.89

[1] Including balance from previous year $724.82.
[2] Including balance from previous year $1,094.15.

the act of Feb. 21, 1925 (Purnell Act), for the year ended June 30, 1934

Classified expenditures—Continued										
Fertilizers	Feeding stuffs	Library	Tools, implements, and machinery	Furniture and fixtures	Scientific apparatus	Livestock	Travel expenses	Contingent expenses	Buildings and land	Balance
$74.63	$2,474.43	$200.62	$647.10	$511.77	$2,569.93		$3.25	$68.18	$63.54	
1,375.69	976.46		803.31	956.71	2,545.28	$220.00	2,843.93	37.35	170.00	
23.00	29.78	153.37	262.46	1,335.64	4,023.31		619.58	135.00		
82.50	257.63	33.36	508.67	283.94	2,828.73	14.00	2,237.03	200.20	169.23	
151.19			293.28	88.97	921.41		421.06	26.82	95.93	
		73.49	42.00	103.07	422.05		2,214.05	12.00		
115.99	1,280.48	203.36	1,152.34	936.85	1,044.80		2,869.43	143.56	564.62	$1,286.78
277.20	109.50	19.62	1,560.88	316.15	6,416.02	60.52	1,987.34	5.75	75.28	
688.53	2,925.01	174.15	2,039.20	591.70	709.56	25.80	1,603.47		1,063.02	
27.60	1,864.37	87.36	497.20	307.18	1,585.11	21.00	2,588.85	36.33	326.90	
	713.98	376.84	2,741.10	1,905.58	4,008.90	2.40	1,780.88	18.70	3,515.08	1,392.05
	614.15	5.50	286.68	440.85	1,993.53		6,440.14	73.48		
37.00	2,695.35	23.90	17.93	155.03	947.60	32.60	1,429.33		40.32	
	483.14	11.40	218.08	36.17	974.18	520.84	236.52	24.53	184.44	
	383.64	8.34	2.69	50.00	963.45	2.00	1,118.60			
163.91	1,405.39	1.05	1,331.96	399.58	481.08		1,046.53	210.33	326.62	
1,682.43	1,818.19	112.36	3,650.86	1,107.70	1,473.70	255.40	2,393.48	140.86	166.54	
644.67	16.75	16.00	283.92	488.13	5,260.72		1,410.23			
	199.26	67.12	155.18	701.16	1,302.43	289.33	2,194.59	9.64	43.46	
12.91	553.41	54.39	8.49	105.57	277.09		3,876.58	68.25		
	2,509.25		687.41	1,009.02	1,614.21	753.19	1,331.30	210.50	150.35	
447.59	1,676.12	44.06	1,545.95	49.80	221.60		850.61	9.50	120.33	
36.15	6,451.12	86.34	1,800.16	1,635.58	2,551.71	1,438.65	1,536.35	28.90	4,456.95	
57.77	887.96	68.58	1,276.63	199.31	830.00	302.29	3,008.23	2.55	197.00	
	4,288.62	19.27	313.97	292.19	2,571.53	421.68	2,008.78	10.08	1,082.67	
	2,595.31	21.31	1,184.24	443.96	841.44	761.80	1,957.74	31.83	2,959.57	
598.75	305.61	23.00	1,966.30	296.53	1,053.16	6.06	3,196.00	50.81	691.41	
22.88	263.19	318.66	1,992.21	854.85	780.60	18.95	2,031.73	160.78	756.53	
220.82	3,594.28	16.74	1,761.07	624.44	112.56	1,338.93	2,878.27	69.82	4,518.53	
12.85	192.04	8.55	171.13	496.34	6,637.99		1,472.12			
					186.30		18.46			
118.48	4,324.73	130.57	557.25	298.62	3,088.46	348.05	2,356.80		164.86	
	1,473.33	74.64	637.92	46.80	310.84	2,967.57	203.75	2.72	93.93	
	6,303.43		147.50	85.00	281.90	947.29	38.75			
	4,500.10	7.08	2,685.50	582.75	834.64	58.25	1,106.95	3.00	1,355.70	
35.68	336.25		2,435.38	218.58	908.82		2,800.13	82.59	140.89	
37.94	1,638.70		217.18	83.70	315.36	341.00	2,076.70		1.82	
234.07	1,738.99	115.59	2,822.15	40.65	1,927.74	36.25	270.74	147.00	2,625.11	
562.12	2,642.95	34.46	499.37	880.13	3,044.28	406.76	1,436.22		4,949.16	
	1,386.74	146.06	724.77	3,475.90	725.48	331.50	2,198.54		181.05	
159.62		480.38	1,812.42	1,422.53	1,344.24		528.62	144.33	2,698.52	
	557.88	174.69	277.09	778.61	3,241.91	174.00	1,405.40	781.08	2,043.07	
87.77	40.20	213.67	633.65	956.13	472.13	5.50	4,085.80		840.78	
126.65	236.53	84.91	1,654.47	1,666.27	1,068.77		1,766.74	509.58	1,870.02	
	243.00	35.54	894.65	1,697.73	2,956.67	6.25	3,545.94	971.38	40.53	
17.66	599.16	268.69	996.59	302.58	2,213.41	382.23	2,019.61	15.64	54.23	
160.26	4,926.26	7.28	921.51		1,623.69	840.28	1,522.58	14.98	1,951.23	57.11
	4,017.80			297.12	295.01		1,033.19			
	6,235.18	81.81	659.84	10.11	504.56	445.58	2,112.05	7.55	154.25	
8,294.31	82,765.65	4,084.11	47,779.64	29,566.98	83,307.89	13,775.95	90,112.97	4,465.60	40,903.47	2,735.94

TABLE 10.—*Expenditures from supplementary funds received from within the States for the year ended June 30, 1934*

State	Salaries	abor	Publications	Postage and stationery	Freight and express	Heat, light, water, and power	Chemical supplies	Seeds, plants, and sundry supplies	Fertilizers	Feeding stuffs
Alabama	$66,270.41	$16,211.84	$1,674.00	$1,917.73	$1,044.33	$5,890.48	$326.56	$6,082.07	$3,366.18	$3,488.18
Alaska	2,981.00	476.04		99.75	44.68		16.10	704.19		
Arizona	36,137.10	12,113.97	2,942.55	2,087.96	201.82	688.78	1,573.20	2,688.75	1,723.20	342.52
Arkansas	31,957.80	12,247.37		1,349.81	1,206.01	3,275.54	2,701.19	536.29	370.04	2,051.91
California	352,494.95	140,997.98	17,624.75	15,862.27	5,287.42	18,505.08	18,743.51	31,724.55	6,168.66	39,655.68
Colorado	40,890.34	21,636.01	3,097.03	2,776.97	1,065.84	4,583.89	3,128.39	3,996.42	209.47	5,418.36
Connecticut (State)	103,683.72	54,853.78	658.32	4,275.92	160.33	7,798.15	1,409.53	3,308.26	946.21	147.44
Connecticut (Storrs)	19,106.27	8,732.21	740.65	857.04	224.94	436.19	1,609.62	929.53		2,198.20
Delaware	3,860.00	11,574.02		570.09	511.94	2,599.01	69.33	3,793.47	280.34	3,959.38
Florida	156,837.32	54,573.17	2,182.14	4,022.74	2,065.53	11,304.89	4,943.58	7,937.73	6,836.53	11,379.58
Georgia	1,206.12	3,645.40	193.29	423.07	742.39	2,852.17	43.32	4,169.02	268.39	293.55
Hawaii	8,432.66	3,444.32	16.05	803.45	82.79	1,178.50	1,116.96	2,164.12	418.86	2,582.98
Idaho	8,410.12	4,844.18	537.37	908.50	59.89		998.57	395.32		2,074.22
Illinois	200,472.51	79,109.92	8,981.69	3,581.48			8,951.27	18,065.80	3,422.54	22,214.89
Indiana	184,992.94	90,725.65	3,381.98	24,255.20	2,148.97	6,644.30	15,802.21	6,364.09	6,588.52	28,798.75
Iowa	141,938.72	33,204.70	3,789.37	5,515.30	1,395.07	1,745.78	2,173.10	12,701.45	676.12	7,081.10
Kansas	34,380.22	49,973.37	2,393.38	2,554.63	1,079.88	5,079.21	5,248.54	5,590.71	32.26	9,549.25
Kentucky	125,217.44	38,749.70	426.32	4,347.31	1,381.46	4,282.59	2,722.53	11,296.75	927.50	9,788.34
Louisiana	40,328.15	19,570.79	504.30	814.28	559.59	1,937.26	1,241.72	2,141.47	893.18	894.43
Maine	14,445.96	12,981.95	77.82	373.50	2,051.38	3,276.56	380.44	3,527.38	8.85	961.90
Maryland	32,941.74	22,622.07	1,555.84	1,583.84	1,056.50	4,111.12	1,133.58	3,901.34	1,179.58	7,643.54
Massachusetts	94,484.71	31,627.58	2,958.07	2,212.05	1,013.94	1,603.56	4,056.68	2,870.74	1,169.87	2,951.31
Michigan	129,983.20	58,809.73	13,528.27	2,106.70	778.94	3,700.30	5,555.70	8,694.36	1,901.69	8,780.25
Minnesota	176,035.10	70,414.05	2,072.99	5,687.54	1,022.68	16,343.78	9,792.72	35,826.14		12,183.53
Mississippi	25,212.67	15,339.80	256.20	1,894.77	797.11	7,161.78	105.75	10,677.90	139.80	192.15
Missouri	27,312.36	19,950.10	3,507.14	2,846.09	935.56	1,745.19	3,539.74	3,520.97	387.86	7,412.31
Montana	46,661.00	14,820.10	473.90	2,351.42	175.81	3,575.08	499.49	6,369.81	1.89	5,666.38
Nebraska	64,605.79	21,360.15	1,988.07	2,022.13	799.26	5,873.93	5,366.47	1,934.70	3,726.31	23,311.32
Nevada		357.85	540.46	107.69	64.42	1,367.58	236.32	257.19		
New Hampshire	15,318.50	4,980.27	98.83	806.02	147.94	22.28	932.70	2,147.83	9.07	348.91
New Jersey	316,091.84	12,347.91	5,002.75	10,284.92	783.51	14,589.83	8,184.95	945.16	1,614.40	24,151.78
New Mexico	4,941.04	3,499.86	105.41	220.45	151.21	300.58	18.49	861.04		1,218.01
New York (Cornell)	331,843.80	65,154.61	22,777.67	9,090.10	1,337.08	25,538.22	13,241.61	8,761.17	8,761.17	10,377.62
New York (State)	159,482.30	30,763.12	7,314.48	4,154.46	630.84	15,617.88	4,752.75	438.49		4,381.28
North Carolina	34,466.42	22,615.15	665.70	2,604.89	674.76	3,476.93	1,033.10	3,174.55	3,924.16	4,885.03
North Dakota	19,630.63	8,666.18	4,110.77	1,175.28	1,061.61	21,937.80	978.25	3,421.83	9.60	11,504.79
Ohio	175,570.74	71,015.12	25,044.96	4,288.73	1,469.52	22,821.61	1,938.46	12,813.40	440.59	14,808.06
Oklahoma	63,015.65	11,637.87	1,596.63	1,987.83	1,636.16	1,329.83	482.29	12,437.01	55.00	5,566.57
Oregon	58,634.03	43,260.79	1,082.61	2,354.95	998.41	5,027.57	2,041.66	7,546.23	219.65	4,612.78
Pennsylvania	89,075.17	26,012.90	1,739.82	3,030.40	1,400.04		3,084.48	1,177.71	5,888.56	7,571.09
Rhode Island		1,657.59	109.32	317.57	69.80	173.67	18.33	184.20	5.00	417.70
South Carolina	22,938.00	23,460.43	1,076.77	861.24	833.95	4,646.97	3,659.47	42.13	7,087.56	11,819.38
South Dakota	10,218.00	4,652.07	813.16	308.60	239.73	287.47	104.32	812.69		7,662.03
Tennessee	12,567.75	6,070.72	3.00	653.71	449.10	1,184.19	26.19	1,594.88	97.29	2,322.30

Texas	193, 454. 03	61, 894. 53	7, 511. 79	10, 740. 88	2, 547. 83	5, 013. 02	6, 025. 61	22, 837. 33	----------	16, 171. 24
Utah	19, 696. 94	11, 735. 84	944. 45	1, 948. 35	287. 13	9, 251. 61	963. 00	1, 838. 92	24. 50	666. 83
Vermont	6, 725. 85	6, 710. 92	1, 279. 01	320. 66	51. 70	409. 71	336. 86	67. 73	----------	2, 737. 00
Virginia	43, 236. 16	10, 711. 04	3, 017. 54	1, 662. 62	628. 11	963. 01	290. 82	2, 917. 12	1, 303. 26	2, 835. 08
Washington	24, 711. 16	27, 043. 96	357. 75	1, 228. 83	592. 63	2, 608. 70	2, 058. 69	3, 497. 00	295. 35	4, 794. 21
West Virginia	25, 339. 92	14, 629. 21	824. 25	1, 074. 09	717. 23	4, 164. 70	174. 84	5, 716. 65	1, 362. 59	1, 682. 59
Wisconsin	175, 899. 60	70, 359. 84	8, 794. 98	7, 915. 48	2, 638. 49	9, 234. 73	8, 355. 23	15, 830. 96	3, 078. 24	19, 788. 71
Wyoming	21, 012. 73	10, 506. 36	250. 00	571. 94	237. 74	463. 25	----------	2, 990. 05	----------	4, 795. 98
Total	3,995,090.58	1,474,354.09	170,533.60	165, 821. 23	47, 543. 00	276, 625. 26	162, 193. 22	314, 224. 60	75, 819. 84	386, 140. 42

TABLE 10.—*Expenditures from supplementary funds received from within the States for the year ended June 30, 1934*—Continued

State	Library	Tools, implements, and machinery	Furniture and fixtures	Scientific apparatus	Livestock	Travel expenses	Contingent expenses	Buildings and land	Balance	Total
Alabama	$123.26	$3,943.44	$324.20		$472.16	$3,292.75	$3,361.44	$4,902.76	$67,945.56	$190,637.35
Alaska						74.35			1,030.18	5,426.29
Arizona		1,830.79	1,025.84	$1,000.00	3,523.04	3,179.20	307.00	1,189.50	4,551.92	77,107.14
Arkansas	631.93	1,745.43	126.88	985.38	531.67	953.18	441.39	5,305.69		66,417.51
California	3,524.95	21,149.70	6,168.65	10,574.84	13,218.56	30,843.30	11,456.09	59,924.14	77,311.39	881,237.37
Colorado	468.69	3,306.36	1,167.07	1,332.93	2,761.20	4,875.64	885.73	8,021.48	24,048.78	133,580.60
Connecticut (State)	2,135.31	8,370.15	1,280.90	661.13		9,308.86	2,395.16	1,554.96	2,243.00	205,191.13
Connecticut (Storrs)	250.00	56.04	261.50	337.05		934.87	242.31	762.43	579.59	38,258.44
Delaware	116.01	646.20	33.54		300.00	196.18	484.33	1,594.83	4,751.66	35,340.33
Florida	1,957.78	9,927.43	714.21	1,736.69	2,436.13	9,976.49	940.40	7,443.79	30,330.11	327,546.24
Georgia	603.99	2,370.61	741.41	2.62	1,046.55	1,621.52	1,164.44	5,966.06	8,522.55	35,881.47
Hawaii	7.70	51.53	14.80	24.67	110.87	62.24	1,182.28			21,694.78
Idaho	3.31	645.51	177.25	126.18	475.00	393.73	1,575.24	2,213.46	1,335.29	25,173.14
Illinois	612.09	2,295.33	1,052.26	1,817.14	3,787.05	7,033.52	5,271.91			366,669.40
Indiana	2,951.63	7,492.60	2,145.11	1,778.74	596.07	17,746.64	6,432.28	12,366.72	205,690.95	626,903.35
Iowa	2,045.30	3,341.27	153.05	502.96	2,155.50	10,443.85	1,390.35	3,731.18	6,207.76	240,191.93
Kansas	44.03	8,033.01	764.89	1,636.78	2,874.41	4,325.09	548.48	5,508.42	32,533.25	172,149.91
Kentucky	1,348.91	3,342.00	2,663.38	1,178.69	1,670.96	8,466.08	4,010.74	5,322.78	15,892.26	243,035.74
Louisiana	33.35	3,150.92	72.29	29.47	50.75	2,079.93	1,235.26	1,199.08	2,468.10	79,204.32
Maine	118.21	1,826.83	232.12	216.34	585.00	1,251.58	3,507.96	2,728.94	2,188.40	50,741.12
Maryland	632.39	1,277.50	69.85	1,010.61	183.35	1,858.99	2,062.36	3,196.03	10,021.73	98,041.96
Massachusetts	694.11	2,225.19	727.82	4,175.63	369.79	5,076.91	330.95	1,186.53	60,166.57	219,902.01
Michigan	1,594.20	8,091.97	918.42	1,904.60	2,702.89	9,835.40	1,010.62	2,921.02		262,818.26
Minnesota	1,530.64	3,854.31	8,578.37		2,999.08	5,029.65	2,936.52	15,385.74		369,692.84
Mississippi	14.00	5,990.67	452.77		1,340.00	969.44	1,329.53	3,053.78	28,360.41	103,288.53
Missouri	128.76	3,633.44	666.79	729.49	2,935.05	1,782.14	1,096.36	8,691.50	30,965.24	121,786.09
Montana	34.48	531.84	569.72	92.95	556.21	1,947.26	15.26	4,248.52	10,083.89	98,615.01
Nebraska	194.93	2,101.42	977.90	2,485.37	11,016.31	1,869.49	1,348.21	9,399.29		160,391.05
Nevada	401.15			120.90		705.57	1,072.03	505.13	3,396.75	9,133.04
New Hampshire	97.08	305.09	308.87	571.76	7.50	4,864.17	645.66	1,055.92	15,225.63	47,894.03
New Jersey	584.26	1,678.84	316.91	7,873.55		13,499.32	20,867.29	3,911.81	3,996.12	446,725.15
New Mexico	311.41	895.55	17.05		80.34	478.81	184.74	4,663.14	35,175.61	53,122.74
New York (Cornell)	2,104.99	16,126.86	6,498.77	117,471.37	775.76	20,330.47	3,572.01	3,749.77		667,513.05
New York (State)	2,087.95	10,206.42	562.12			3,061.71	1,305.88	11,494.56	123,860.40	380,114.64
North Carolina	310.38	2,428.43	152.32	70.09	1,410.85	7,554.68	1,245.66	7,630.46	1,809.99	100,133.55
North Dakota	271.55	2,782.12	948.70	146.10	690.14	3,433.16	2,664.06	4,261.34		87,693.91
Ohio	680.27	5,095.37	31.49	236.79	4,731.92	4,998.60	3,481.45	3,536.89	336,981.70	689,985.67
Oklahoma	986.27	1,396.22	842.09	822.07	7,281.49	5,572.82	18,991.66	16,291.49	10,847.88	162,776.83
Oregon	112.97	2,497.98	43.90	407.61	2,143.00	5,418.96	10,056.40	298.83	38,261.16	185,019.49
Pennsylvania	111.46	407.68	200.63	341.81	668.77	5,888.55		1,984.96	4,568.55	153,152.49
Rhode Island	41.00	164.14	160.38	29.42	1.30	441.27	36.43	869.00	892.91	5,589.03
South Carolina		6,343.93	770.60	2,077.05	2,328.61	2,247.80	118.71	11,576.73	11,305.28	113,194.61
South Dakota		386.28	66.60	388.00	2,802.75	932.44	40.53	1,250.71	8,062.94	39,028.32
Tennessee	260.60	2,314.96	64.10	2.00	642.50	305.05	709.26	3,666.42		32,934.11

Texas	1,682.24	6,457.80	3,293.97	1,608.31	11,808.39	24,679.39	22,624.30	21,855.94	69,750.94	489,957.41
Utah	339.62	186.17	381.74	37.71	80.50	2,651.32	317.13	2,637.54	12,251.11	66,240.45
Vermont	113.75	89.93	33.80	52.13		1,953.50	97.78	383.61	637.86	22,001.80
Virginia	854.88	1,924.17	635.31	1,046.74	373.18	4,379.89	181.98	8,956.70	63.24	85,980.85
Washington	1,162.05	2,020.11	70.48	195.20	564.00	2,501.14	96.36	3,456.87		77,254.49
West Virginia	135.86	1,155.98	159.65	34.69	1,105.00	663.78	839.53	1,269.05	9,273.23	70,322.84
Wisconsin	1,759.00	10,553.98	3,078.24	5,276.99	6,596.23	15,391.22	5,716.74	29,902.93	39,577.41	439,749.00
Wyoming		1,219.92			335.75	1,256.34	2,882.87	3,881.79	24,636.57	75,041.29
Total	36,208.70	187,869.42	50,718.71	173,150.55	103,125.58	278,638.24	154,711.06	326,910.22	1,377,803.87	9,757,482.19

TABLE 11.—*Disbursements from the United States Treasury to the States and Territories for agricultural experiment stations under the acts of Congress approved Mar. 2, 1887, Mar. 16, 1906, Feb. 24, 1925, May 16, 1928, and Feb. 28, 1929*

State or Territory	Hatch Act		Adams Act		Purnell Act	
	1888–1933	1934	1906–33	1934	1926–33	1934
Alabama	$688,946.42	$15,000.00	$386,619.89	$15,000.00	$380,000.00	$60,000.00
Alaska	30,000.00	15,000.00				
Arizona	654,803.10	15,000.00	389,955.61	15,000.00	380,000.00	60,000.00
Arkansas	688,139.12	15,000.00	389,900.00	15,000.00	380,000.00	60,000.00
California	690,000.00	15,000.00	389,926.84	15,000.00	380,000.00	60,000.00
Colorado	689,718.82	15,000.00	388,638.93	15,000.00	380,000.00	60,000.00
Connecticut	690,000.00	15,000.00	390,000.00	15,000.00	380,000.00	60,000.00
Dakota Territory	56,250.00					
Delaware	688,382.87	15,000.00	385,475.12	15,000.00	378,935.61	59,275.18
Florida	689,966.04	15,000.00	389,996.06	15,000.00	376,523.74	60,000.00
Georgia	685,593.43	15,000.00	377,092.87	15,000.00	380,000.00	60,000.00
Hawaii	60,000.00	14,919.17	20,951.14	11,000.00		
Idaho	614,324.13	15,000.00	385,842.22	15,000.00	380,000.00	60,000.00
Illinois	689,548.21	14,920.02	389,851.62	14,943.29	379,931.91	58,905.85
Indiana	689,901.19	15,000.00	390,000.00	15,000.00	380,000.00	60,000.00
Iowa	690,000.00	15,000.00	390,000.00	15,000.00	377,965.17	60,000.00
Kansas	689,995.00	15,000.00	390,000.00	15,000.00	380,000.00	60,000.00
Kentucky	689,996.57	15,000.00	390,000.00	15,000.00	380,000.00	60,000.00
Louisiana	690,000.00	15,000.00	390,000.00	15,000.00	380,000.00	60,000.00
Maine	689,999.62	15,000.00	390,000.00	15,000.00	380,000.00	60,000.00
Maryland	689,967.40	15,000.00	389,236.48	15,000.00	380,000.00	60,000.00
Massachusetts	689,617.70	15,000.00	390,000.00	15,000.00	380,000.00	60,000.00
Michigan	689,676.10	15,000.00	386,341.20	15,000.00	380,000.00	60,000.00
Minnesota	689,917.78	15,000.00	389,345.00	15,000.00	380,000.00	60,000.00
Mississippi	690,000.00	15,000.00	390,000.00	15,000.00	380,000.00	60,000.00
Missouri	685,097.24	15,000.00	389,999.90	15,000.00	380,000.00	60,000.00
Montana	600,000.00	15,000.00	387,417.04	15,000.00	380,000.00	60,000.00
Nebraska	689,932.16	15,000.00	390,000.00	15,000.00	380,000.00	60,000.00
Nevada	689,214.32	15,000.00	288,180.28	15,000.00	380,000.00	60,000.00
New Hampshire	690,000.00	15,000.00	390,000.00	15,000.00	380,000.00	60,000.00
New Jersey	689,949.97	15,000.00	389,392.06	15,000.00	380,000.00	60,000.00
New Mexico	654,509.05	15,000.00	390,000.00	15,000.00	380,000.00	60,000.00
New York	689,757.18	15,000.00	389,463.01	15,000.00	380,000.00	60,000.00
North Carolina	690,000.00	15,000.00	375,000.00	15,000.00	380,000.00	60,000.00
North Dakota	631,502.26	15,000.00	389,638.85	15,000.00	380,000.00	60,000.00
Ohio	690,000.00	15,000.00	388,514.02	15,000.00	380,000.00	60,000.00
Oklahoma	614,002.16	15,000.00	369,535.19	15,000.00	380,000.00	60,000.00
Oregon	675,156.64	15,000.00	385,000.00	15,000.00	380,000.00	60,000.00
Pennsylvania	689,957.43	15,000.00	389,995.41	15,000.00	380,000.00	60,000.00
Rhode Island	690,000.00	15,000.00	384,520.20	15,000.00	380,000.00	60,000.00
South Carolina	689,542.15	15,000.00	388,460.12	15,000.00	380,000.00	60,000.00
South Dakota	633,250.00	15,000.00	385,000.00	15,000.00	380,000.00	60,000.00
Tennessee	690,000.00	15,000.00	390,000.00	15,000.00	380,000.00	60,000.00
Texas	690,000.00	15,000.00	387,592.26	15,000.00	380,000.00	60,000.00
Utah	555,000.00	15,000.00	389,821.04	15,000.00	380,000.00	60,000.00
Vermont	690,000.00	15,000.00	390,000.00	15,000.00	380,000.00	60,000.00
Virginia	687,824.12	15,000.00	389,949.01	15,000.00	380,000.00	60,000.00
Washington	627,102.65	15,000.00	386,080.11	15,000.00	380,000.00	60,000.00
West Virginia	689,978.71	14,981.37	387,859.12	15,000.00	380,000.00	60,000.00
Wisconsin	690,000.00	15,000.00	390,000.00	15,000.00	380,000.00	60,000.00
Wyoming	675,000.00	15,000.00	390,000.00	15,000.00	380,000.00	60,000.00
Total	32,591,529.54	749,820.56	18,640,591.50	730,943.29	18,233,356.43	2,878,181.03